Applied Artificial Intelligence

COURSE CODE: 18B1WEC533

COURSE CREDITS: 3

CORE/ELECTIVE: PROFESSIONAL ELECTIVE

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

1. Study of design of expert systems which exhibit intelligent behavior.
2. Study of design and development of products using Artificial Intelligence.
3. Participate in the design of systems that act intelligently and learn from experience.
4. To study State of the Art algorithms with engineering applications.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Basic methods and algorithms from area of artificial intelligence	Familiarity
CO-2	Identify problems where artificial intelligence techniques are applicable.	Assessment
CO-3	Analysis of problem solving, knowledge and reasoning	Assessment
CO-4	Study of application domains.	Usage

Course Contents:

Unit	Contents	Lectures required
1	Introduction to Artificial Intelligence (AI): Overview of AI, Philosophy of AI, AI Foundation and History, Applications of AI in modern world.	8
2	Intelligent Agents: Agents and Environments, The structure of Agents, Agent Programs, Simple reflex Agents, Model based reflex Agents, Goal based Agents, Utility based Agents, Learning Agents.	8
3	Problem Solving, Knowledge and Reasoning: Problem solvingAgents, Formulating Problems, Searching for Solutions, UninformedSearch Strategies, Knowledge based agents, KnowledgeRepresentation, Uncertain Knowledge and Reasoning	7

4	Machine Learning: Machine learning concepts, K-nearest neighbours and training-testingLogistic regression, Decision trees, Neuralnetworks, Clustering, Association rules	7
5	Reinforcement Learning: Learning from Observations, Knowledge inLearning, Statistical Learning, Reinforcement Learning, PerceptionalAnalysis, Communication as Action	6
6	Applications of AI Techniques: Semantic Interpretation, Probabilistic Language Processing, Robotic Hardware and Software Architectures, Probabilistic Inference, Planning and Search, Localization, Tracking and Control.	6
Total lectures		42

Suggested Text Book(s):

1. Stuart J. Russel and Peter Norvig: Artificial Intelligence: A Modern Approach, Third Edition, Pearson Education Limited, 2014.
2. E. Rich and K. Knight: Artificial Intelligence and Applications, Third Edition, Tata McGraw Hill, 2012.

Suggested Reference Book(s):

1. P. Kulkarni and P. Joshi: Artificial Intelligence, Second Edition, PHI Learning Private Limited, 2015.
2. P. H. Winston: Artificial Intelligence and Applications, Third Edition, PHI Learning Private Limited, 2017.

Other useful resource(s):

Link to topics related tocourse:

i. https://nptel.ac.in/courses/106105077/
ii. https://nptel.ac.in/courses/106105079/
iii. https://www.tutorialspoint.com/artificial_intelligence/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered up to T-1
2	T-2	25	1.5 Hours	Syllabus covered up to T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes(2) -10 Attendance - 5

ANALOGUE AND DIGITAL COMMUNICATIONS

(Core Subject)

Course Code:	17B11EC412	**Semester:**	4th Semester, B. Tech (ECE)
Credits:	4	**Contact Hours:**	L-3, T-1, P-0

Course Objectives

The objectives are to study

1. To introduce the basic concepts of analogue and digital communication systems, and to equip students with various modulation techniques used for communication.

Course Outcomes

After studying this course the students would gain enough knowledge

1. The students will have the knowledge of components of analogue communication system.
2. The students will have the ability to analyze the concept of various methods used for baseband/band pass analogue transmission and detection.
3. The students will be able to evaluate the performance of analogue communications in the presence of noise.
4. The students will have the knowledge how we can covert analog signal to digital signal with the help of sampling and PCM.
5. The students will have the knowledge of components of digital communication system.
6. The students will have the ability to analyze various modulation methods for transmission of digital information.

Course Contents

Unit	Topics	References (chapter number, page no. etc)	Lectures
1.	Elements of an electrical communication system; Characteristics of communication channel and their mathematical modeling; Signal models: deterministic and random; signal classification; Convolution Integral and response of LTI system; Fourier series representation, Parseval's theorem; Fourier transform; Probability theory, Random Process: mean, correlation and covariance; stationary and ergodic processes; power spectral density; Gaussian Process.	Simon Haykin : Chapter 2	4
2.	Concept of modulation and demodulation, Continuous wave (CW) modulation: amplitude modulation (AM) - double sideband (DSB); double sideband suppressed carrier (DSBSC); single sideband suppressed carrier (SSBSC) and vestigial sideband (VSB) modulation, angle modulation - phase modulation (PM) &	B.P.Lathi : Chapter 2 ,3 & 12	13

	frequency modulation (FM); narrow and wideband FM. Representation of narrowband noise; receiver model, signal to noise ratio (SNR), noise figure, noise temperature, noise in DSB-SC, SSB, AM & FM receivers, pre-emphasis and de-emphasis		
3	Sampling process, sampling theorem for band limited signals; pulse amplitude modulation (PAM); pulse width modulation (PWM); pulse position modulation (PPM) ; pulse code modulation (PCM); line coding; differential pulse code modulation; delta modulation and adaptive delta modulation, Basics of time division multiplexing, noise consideration in PAM and PCM systems.	B.P.Lathi : Chapter 6 Simon Haykin : Chapter 5	10
4	Overview of geometric representation of signals, Gram-Schmidt Orthogonalization procedure; Basic digital modulations schemes: Phase shift keying (PSK), amplitude shift keying (ASK), frequency shift keying (FSK) and Quadrature amplitude modulation (QAM); coherent demodulation and detection; probability of error. Basics of equivalent complex baseband representation of digitally modulated signals.	Simon Haykin : Chapter 7	10
5	Measure of information, Source encoding, Error free communication over noisy channel, Channel capacity of discrete memory less channel, Channel capacity of continuous memory less channel, Frequency selective channel capacity, MIMO communication system. Introduction, Redundancy for error correction, Linear block codes, Cyclic codes, Effect of error correction, Convolution codes, Trellis diagram of block codes	Robert G. Gallager :	7
		Total Number of Lectures	44

Evaluation Scheme

1. Test 1 :15 marks
2. Test 2 : 25 marks
3. Test 3 : 35 marks
4. **Internal Assessment** : 25 marks
    - 10 Marks : Class performance, Tutorials & Assignments
    - 10 Marks : Quizzes
    - 5 marks : Attendance

Text Books

1. Haykin, Simon : An introduction to analog and digital communications. John Wiley & Sons.
2. Lathi, B.P. : Modern Analog and Digital Communication Systems. Oxford.
3. Taub, Schilling. : Principles of Communication Systems, McGrawHill.
4. Carlson, Crilly : Communication Systems, McGrawHill.
5. Information theory and Reliable communication, Robert G. Gallager, Wiley.

Reference Books

1. Haykin, Simon : An introduction to analog and digital communications. John Wiley & Sons.
2. Lathi, B.P. : Modern Analog and Digital Communication Systems. Oxford.
3. Taub, Schilling. : Principles of Communication Systems, McGrawHill.
4. Carlson, Crilly : Communication Systems, McGrawHill.

ADVANCED LINEAR ALGBERA 17P1WMA231

Lectures 3, Tutorials 0, Practical 0 Credits 3

Prerequisites: An undergraduate class on Linear Algebra

Objectives: The goal of the course is to provide a thorough and comprehensive treatment of the main concepts and theorems of linear algebra.

Course Assessment:

Teacher Assessment (Based on Assignments, quizzes etc.)	25	Duration
Test-1	15	1 Hour
Test-2	25	1 Hour 30 Min
End Semester Exam	35	2 Hours
Total	100	

Course Outcomes: Upon successful completion of this course students will be able to:

- understand the linear algebra associated to eigenvalue problems, inner product spaces, Gram-Schmidt and other decomposition theorems with their applications and significance.
- familiarize the theory and computation of the Jordan canonical form of matrices and linear maps; bilinear forms, quadratic forms, and choosing canonical bases for these.
- compute the QR-factorization of a square matrix; utilize the Least Squares method to solve linear systems of equations.
- use geometric properties and strategies to model, solve problems, and conceptually extend these results to higher dimensions; to critically analyze and construct mathematical arguments that relate to the study of introductory linear algebra (theorem-proofs and reasoning).

Topics Covered:

Unit-I: Vector spaces, subspaces, basis, change of bases, eigenvalues, eigenvectors, characteristic polynomial, minimal polynomial, Cayley-Hamilton theorem, algebraic and geometric multiplicity, diagonalization.

Unit-II: Cauchy-Schwartz inequality, orthonormality, Gram-Schmidt orthogonalisation process, linear functionals, dual spaces and dual bases, Hermitian adjoint of a matrix and transformation, orthogonal matrices and the QR-Decomposition, least squares solutions of linear systems.

Unit-III: Unitary matrices and transformations, normal matrices and transformations, unitary diagonalization of normal matrices, Spectral theorem and applications to hypersurfaces; Jordan canonical form, rational canonical form, invariant factors, elementary divisors, Primary Decomposition Theorem (Hermitian, unitary and normal matrices and their applications).

Text books:

1. Gilbert Strang, ``Introduction to Linear Algebra,'' Fifth Edition, Wellesley-Cambridge Press, 2016.
2. Stephen H. Friedberg, Arnold J. Insel, Lawrence E. Spence, ``Linear Algebra,'' Fourth edition, N.J: Pearson Education, 2003.

Reference Books:

3. K. Hoffman and R. Kunze, ``Linear Algebra,'' Second Edition, Prentice Hall of India, 2005.
4. Steven. J. Leon, ``Linear Algebra with Applications,'' Eighth Edition, Pearson, 2009.

ANALOGUE AND DIGITAL COMMUNICATIONS LAB

(Core Subject)

Course Code:	17B11EC471	**Semester:**	4th Semester, B. Tech (ECE)
Credits:	1	**Contact Hours:**	L-0, T-0,P-2

Course Objectives

1. Familiarize the students with basic analog communication systems.
2. Integrate theory with experiments so that the students appreciate the knowledge gained from the theory course, e.g., amplitude and frequency modulation.
3. Familiarize the student digital communication techniques which are widely used these days.
4. At the conclusion of the course, the student should have a far greater capacity to design, any communication system

Course Learning Outcomes

After studying this course the students shall be able to:

1. Able to design analog modulation circuits as amplitude and frequency modulation.
2. Design various line coding techniques.
3. Design the circuit to convert analog signals to digital signals.
4. Design different digital modulation circuits

List of Experiments

1. To design and implement Amplitude modulator and Demodulator.
2. To design and implement Frequency Modulator and Demodulator.
3. To design and implement Pulse Amplitude Modulator (PAM), Pulse Width Modulator (PWM), Pulse Position Modulator (PPM).
4. To design and implement sample and hold circuit.
5. Design and Generation of random binary signals.
6. Generation Unipolar NRZ, Polar NRZ, Unipolar RZ and Polar RZ line codes.
7. Design and implementation of Delta Modulator for analogue signals
8. Design, implementation and study of BASK Modulator and demodulator
9. Design, implementation and study of BPSK Modulator and demodulator.
10. Design, implementation and study of BFSK Modulator and demodulator

Evaluation Scheme

1. Mid Sem Evaluation 20 Marks
2. End Sem Evaluation 20 Marks

3. Attendance	15 Marks
4. Class response	30 Marks
5. File	15 Marks
Total Marks	**100 Marks**

Text Books

1. Haykin, Simon : An introduction to analog and digital communications. John Wiley & Sons.
2. Lathi, B.P. : Modern Analog and Digital Communication Systems. Oxford.

complete cost estimate and construction schedule. There will be one midterm evaluation, a presentation at the end followed by a viva-voce examination

SYLLABUS FOR ELECTIVE COURSES

Leadership and Human Resource Management: Overview of project management, TEAM, essential concepts of leadership and management, building leadership skills, leadership characteristics, leadership theories, leaders & managers, winning strategies for the construction industry, constructive communication, human motivation, integrating motives and emotions into a holistic pattern of leadership, personal orientation motive in leadership, place orientation and leadership, time orientation and leadership, organization strategy, crisis management, case studies

International Construction Business Management: Introduction, preparation for entry into international construction, international trade and the nature of international construction, international construction finance; key factors in operating and sustaining a business, business development and project management in international markets, impact of social, cultural, legal and financial aspects of international contracting, logistics of labor, materials, and equipment in a foreign environment, models of human resource management applied to international construction, the global market and competitive advantage, case studies- international consultant & contract, special problems

Value Engineering: Introduction, concept of cost & value, objectives, fundamentals and principles, methodology, techniques and applications of value engineering, project scope and budget, cost control, cost models, function analysis, life cycle costing, integrating value engineering in planning, design and construction, case studies

Construction Methods Improvement: Methods analysis, work analysis, work methods improvement, productivity analysis, measuring productivity, time study, standard data systems, predetermined time systems, work sampling, physiological work measurement, labour reporting, improving productivity, introduction to ergonomics, incentives to increase productivity, alternative methods for increasing productivity, case studies

Construction Information Systems: Management information systems in construction industry,current integration of computer aided design (CAD), computerized project management systems, use of automated programs for planning, scheduling, estimating and controlling construction projects, data processing and applications in pricing, tendering, scheduling and cost control system, simulation of construction operations,internet technology, web applications in construction, use of project planner software

Advances in Construction Materials: Newer and improved materials of construction, steel having greater ductility, tensile strength and corrosion resistance, high performance concrete, self-compacting concrete, chemicals, epoxies, latexes and bonding agents for repairs, geotextiles and geomembranes

Facilities Management : Introduction and overview of facility management, long range and annual facility planning, financial forecasting budgeting and appropriations; real estate considerations, analysis and planning; interiors and space planning; construction and renovation; types of maintenance programs, maintenance technologies, commissioning existing buildings, metering for operations and maintenance, O&M for major equipment types, operational efficiency, computerized maintenance management system, administrative services and technology

Antenna Theory and Design

COURSE CODE: 17B11EC731

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Basics of Electromagnetic Engineering

Course Objectives:

1. To make students understand the fundamental theory and concepts of antenna and propagation of waves.
2. Make them aware to the radiation characteristics of different types of antennas, their measurement and applications of various antennas.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO1	Comprehend the fundamental theory and concepts of radiation, antenna and significance of antenna parameters.	Familiarity
CO2	Assess the power and usefulness of UHF, VHF and Microwave Antennas, microstrip patch antennas their requirements, specifications, characteristics and design relations.	Assessment
CO3	To define and distinguish between different phenomenon of wave propagation (ground wave, space wave and sky wave), their frequency dependence, and estimate their characteristics, identifying their profiles and parameters involved.	Assessment
CO4	Reveal different applications of the various types of antenna to solve engineering and other problems	Usage

Course Contents:

Unit	Contents	Lectures required
1	ANTENNA FUNDAMENTALS: Introduction, Radiation Mechanism – single wire, 2 wires, dipoles, Current Distribution on a thin wire antenna. Antenna Parameters - Radiation Patterns, Beamwidth, Beam Area, Radiation Intensity, Beam Efficiency, Gain & Directivity, Antenna Apertures, Aperture Efficiency, Antenna temperature and signal to noise ratio.	7
2	ELECTROMAGNETIC RADIATION: Potential functions and the electromagnetic field, Oscillating electric dipole derivations for E and H field components in spherical coordinate systems, Power Radiated by a current element, Application of various antennas, Radiation from quarter wave monopole and half wave dipoles, equality of directional patterns and effective lengths of transmitting and receiving antennas, directional properties of dipole antennas, antenna feeding methods.	8
3	ANTENNA ARRAYS: Analysis and Synthesis Review of antenna array basics, Linear arrays, circular array, planar (2D) arrays, sum and difference patterns, Effect of mutual couplings, Phased array antennas, scan principles, Non uniform arrays, Dolph Chebyshev Arrays Binomial Arrays.	6

4	Aperture Antennas Radiation from an aperture in an infinite ground plane, Radiation from rectangular and circular apertures, Radiation from a slotted rectangular waveguide Horn antennas: E plane and H plane sectoral horns, Pyramidal horn, Conical horn Reflector antennas parabolic reflector, methods of analysis, dual reflector antennas, offset reflector antenna, gain and efficiency calculations, scanning properties and cross polarization Lens antennas and their applications	7
5	Broadband and Frequency Independent Antennas Helical antenna: Normal mode andaxial mode helix Spiral antennas, Log Periodic antennas.	7
6	Microstrip Antennas Rectangular patch antenna: cavity and transmission line models, Circular patch antenna Coupling mechanisms, circular polarization, Microstrip arrays, Broadband and Multi band microstrip antennas, Compact Microstrip Antennas.	7
Total lectures		42

Suggested Text Book(s):

1. E.C.Jordan and Balmain,"Electromagnetic waves and radiating systems", 2nd Edition, PHI, 2006
2. Constantine A. Balanis,"Antenna Theory Analysis and Design", 2nd Edition, John Wiley, 2007.
3. John D.Kraus, Ronald J Marhefka and Ahmad S Khan, "Antennas for all Applications", 3rd Edition, Tata McGraw-Hill Book Company, 2007.
4. G.S.N Raju, "Antenna Wave Propagation", 1st Edition, Pearson Education, 2004.
5. R.E Collins, "Antennas and Radio wave propagation", 3rd Edition, Tata McGraw-Hill Book Company, 2005.

Other useful resource(s):

1. https://nptel.ac.in/courses/117107035/
2. https://nptel.ac.in/courses/108/101/108101092

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes(2) -10 Attendance - 5

Antenna Theory and Design Lab

COURSECODE:17B17EC771

COURSE CREDITS: 1

CORE/ELECTIVE:ELECTIVE

L-T-P: 0-0-2

Pre-requisite: None

Course Objectives:

1. The main objective of the lab is to be familiar with unique equipment's used in microwave devices and antenna systems.
2. Gaining hands on experience of some unique microwave circuits and antenna units.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO1	Know about the different types of devices and their usage in microwave frequencies.	Familiarity
CO2	Familiarize the students with handling, working and tuning of various equipment pertinent to the hardware experiments in the field of Microwave and antennas.	Familiarity
CO3	Integrate theory with experiments so that the students appreciate the knowledge gained from the theory course, e.g., microwave devices and antennas, and applied in practice.	Assessment
CO4	Familiarize the students with some antenna hardware and help them to connect and visualize the properties of the same.	Familiarity
CO5	At the conclusion of the course, the student should have a far greater capacity to design, measure, and understand novel microwave and antenna prototypes.	Usage

List of Experiments

S. No	Description	Hours
1	Introduction to microwave test bench and details of various waveguide components.	2
2	To determine the frequency and wavelength in a rectangular waveguide working on TE10mode.	2
3	To study the characteristics of Gunn oscillator & to plot the V-I characteristics of Gunn diode.	2
4	Design a coaxial feed rectangular microstrip antenna using a substrate (RT/duroid 5880) with dielectric constant of 2.2, h=0.1588 cm so as to resonate at 10GHz.	2
5	Design inset feed microstrip antenna with overall dimensions of L= 0.906 cm and W= 1.186 cm, substrate height h=0.1588 cm and dielectric constant of 2.2 operating at 10GHz.	2
6	Design a circular microstrip patch antenna using a substrate (RT/duroid 5880) with a dielectric constant of 2.2, h=0.1588 cm so as to resonate at 10GHz.	2

7	Design a circularly polarized Rectangular microstrip patch antenna at 2.4 GHz.	2
8	Design a circularly polarized Circular microstrip patch antenna at 2.4 GHz.	2
9	Design a 2×2 rectangular microstrip patch antenna array at 5 GHz considering the effect of mutual coupling among individual antenna elements.	2
10	Plot the radiation pattern of waveguide horn antennas: (a) E-plane Horn,(b) H-plane Horn & (c) Pyramidal Horn	2
11	Introduce different phase shifts in microwaves using microwave phase shifters.	2
Total Lab hours		22

Suggested/Resources:

1. Pozar David M, "Microwave Engineering", 8th Edition, John Wiley & Sons, 2009
2. Liao, Samuel Y. "Microwave solid-state devices". 1st Edition, Prentice Hall, 1985.
3. Constantine A. Balanis,"Antenna Theory Analysis and Design", 2nd Edition, John Wiley, 2007.
4. R.E Collins, "Antennas and Radio wave propagation", 3rd Edition, Tata McGraw-Hill Book Company, 2005.

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Attendance	15 Marks
4	Lab Assessment	45 Marks
	Total	100 marks

Business Analytics

COURSE CODE:18B1WHS632

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

1. To understand facets of business analytics within an organization.
2. To gain an understanding of how managers use business analytics to formulate and solve business problems and to support managerial decision making.
3. To become familiar with the processes needed to develop, report, and analyze business data.
4. To analyze real world business problems, not only with the context of the company but also with the context of the society, with the help of modern concepts and tools and techniques of the concerned area.
5. To provide an optimal solution which benefits both the company and the society as a whole.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Understanding the concepts and dimensions of business analytics	Familiarity
CO-2	Formulations of business analytics problems	Assessment
CO-3	Developing and reporting of the problems after proper assessment	Assessment
CO-4	Analyzing problems using different tools and techniques of business analytics	Usage
CO-5	Designing an optimal strategy to help the company	Usage

Course Contents:

Unit	Contents	Lectures required
1	**Introduction:**Introduction and importance to Business Analytics, Categorization of Analytical Methods and Models, Business Analytics in Practice – Marketing, HR, Finance etc.	3
2	**Business Analytics Models:** Overview and Deployment of Business Analytics Models	2

3	**Exploring Data:** Describing the distribution of single variable – Types of data, categorical variables etc,; Relationships among variables – categorical variables, categorical and numerical variables and numerical variables	**6**
4	**Probability and Decision Making:** Probability and distributions – single random variables; Distributions – normal, binomial, poisson and exponential; Decision making under uncertainty – elements of decision analysis, precision tree, Bayes' rule, multistage decision problems; Applications in Business Management	**7**
5	**Statistical Inference:**Sampling and sampling distributions; Confidence Interval Estimations; Hypothesis testing; Applications in Business Management	**7**
6	**Regression Analysis:**Regression Analysis – Estimation; Regression Analysis – Inference; Applications in Business Management	**8**
7	**Simulation Modeling:** Introduction to Simulation Modeling; Simulation Models – Operations, Financials, Marketing Applications in Business Management	**9**
Total Number of Lectures		**42**

Suggested Text Book(s):

1. S. Christian Albright and Wayne L. Winston: Business Analytics: Data Analysis and Decision Making, Cengage Learning, 5e

Suggested Reference Book(s):

1. Jeffrey D Camm et al.: Essentials of Business Analytics, Cengage Learning
2. Halady P: Business Analytics: An Application Focus, PHI
3. Seema Acharya and R. N. Prasad: Fundamentals of Business Analytics, Wiley
4. Some real life data from different government/non-government sources will also be discussed and analysed.

EvaluationScheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1-> Unit 1, 2 and 3
2	T-2	25	1.5 Hours	Syllabus covered upto T-2->Upto T1 + Unit 4and 5 (partially)

3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Attendance – 5 Class Performance - 10 Quizzes –10

1. **Introduction of new Elective Courses**

   It is proposed to introduce new electives as per details below and recommend attached course descriptions (Annexure-I, II, and III).

   (a) Computer Game Design
   (b) Real World Applications of Algorithms
   (c) Mobile and Distributed Computing

Annexure-I

Course Description of "Computer Game Design"

Course Code: 17B1WCI812

Course Credits: 3 (3-0-0)

Course description and Objective and Outcomes of the Course

Course description:

This course is an introduction to current and future technologies for computer game design and scripting. Topics include graphics, game scripting, game engines, motion control, the narrative in games, game interfaces, artificial intelligence, music and sound, "Serious Games" and social and interface issues of game development.

Students enrolled in Computer Game Design program will have the opportunity to learn techniques for using interactive storytelling to design games. Program coursework exposes students to design processes such as planning, prototype development, and testing. Students also learn about the theoretical and conceptual understanding of the field of game design, along with practical exposure to the process of creating a game. The coursework describes the deepest and most fundamental principles of game design.

Course Objectives:

In this class

- We will discuss games and game design. It includes the history and philosophy of games, the game production process.
- We will discuss introduction to the electronic game design and development careers
- We will discover what the components of games are, and what parts of games are influenced by their design.
- We will learn several ways to approach the design of a game, and processes and best practices for prototyping, playtesting and balancing a game after it has been designed.

Student Learning Outcomes:

By the end of the Game Design course, students will demonstrate proficiency with:

- Identifying the fundamental skills and techniques of game design
- Applying the fundamental skills and techniques of game design in the construction of a game prototype
- Refining a game prototype through a productive cycle of playtesting
- Participating in the iterative process in a mutually respectful, collaborative team environment
- Executing a well-planned presentation that includes an analysis of the final product and game design process

- You will be familiar with the (relatively small) body of work that is accepted in the game industry as the theoretical foundation of game design.
- You will also be comfortable enough in processes to start designing your own games, as well as critically analyzing other people's games.

Course Syllabus:

Topics		HRS
1	**The Role of the Game:** An Advocate for the Player, An Advocate for the Player, Passions, and Skills, A Play centric Design Process, Designers You Should Know, The Iterative Design Process, Designing for Innovation, Conclusion, Designer Perspective: Peter Molyneux, Designer Perspective: Warren Spector, Further Reading.	**3**
2	**The Structure of Games:** Go Fish versus Quake, Engaging the Player, What is a Puzzle?, The Sum of the Parts, Defining Games, Beyond Definitions, Conclusion, Designer Perspective: American McGee, Designer Perspective: Sandy Petersen, Further Reading.	**3**
3	**Working with Formal Elements:** Players, Persuasive Games, Objectives, Procedures, Resources, Conflict, Boundaries, Outcome, Conclusion, Designer Perspective: Lorne Lanning, Designer Perspective: Marc LeBlanc, Further Reading.	**3**
4	**Working with Dramatic Elements:** Challenge, Play, Premise, Character, Story, The Two Great Myths of Interactive Storytelling, World Building, The Dramatic Arc, Conclusion, Designer Perspective: Dr. Ray Muzyka, Designer Perspective: Don Daglow, Further Reading.	**3**
5	**Working with System Dynamics:** Games as Systems , System Dynamics , Deconstructing Set, Interacting with Systems, A Conversation with Will Wright, Tuning Game Systems, Table of Contents ix Conclusion, Designer Perspective: Alan R. Moon, Designer Perspective: Frank Lantz, Further Reading.	**3**
6	**Conceptualization:** Coming Up With Ideas, Brainstorming Skills, Alternate Methods, Editing and Refining, Electronic Arts Preproduction Workshop, Turning Ideas into a Game, Where Do Game Ideas Come From?, Conclusion, Designer Perspective: Bill Roper, Designer Perspective: Josh Holmes, Further reading.	**3**
7	**Prototyping:** Methods of Prototyping, Catastrophic Prototyping, and Other Stories, Prototyping Your Original Game Idea, The Design Evolution of Magic: The Gathering, Making the Physical Prototype Beer, Beyond the Physical Prototype, Conclusion, Designer Perspective: James Ernest, Designer Perspective: Katie Salen, Further Reading.	**3**
8	**Digital Prototyping:** Types of Digital Prototypes, Using So ware Prototypes in Game, Prototyping for Game Feel, Designing Control Schemes, Prototyping Cloud, Selecting Viewpoints, x Table of Contents Effective Interface Design, Prototyping Tools, Conclusion, Designer Perspective: David Perry, Designer Perspective: Brenda Braithwaite, Further Reading.	**3**
9	**Play testing:** Play testing and Iterative Design, Recruiting Play testers, Conducting a Play testing Session, Methods of Play testing, 256 Why We Play Games, The Play Matrix, Taking Notes, Basic Usability Techniques, Data Gathering, Test Control Situations, How Feedback from Typical Gamers Can Help Avoid Disappointing Outcomes, Play testing Practice ,Conclusion , Designer Perspective: Rob Daviau, Designer Perspective: Graeme Bayless, Further reading.	**3**

10	**Functionality, Completeness, and Balance:** What Are You Testing For?, Is Your Game Functional?, Is Your Game Internally Complete?, Is Your Game Balanced? , A Conversation with Rob Pardo, Techniques for Balancing Your Game, Conclusion, Designer Perspective: Brian Hersch, Designer Perspective: Heather Kelley, Further Reading.	**3**
11	**Fun and Accessibility:** Is Your Game Fun?, Improving Player Choices, The Core Mechanic: Game Design as Activity Design, Fun Killers, Beyond Fun, Is Your Game Accessible?, Using Audio as a Game Feedback Device, Conclusion, Designer Perspective: Richard Hilleman, Designer Perspective: Bruce C. Shelley, Further Reading.	**3**
12	**Team Structures:** Team Structure, Developer's Team, Applying for a Job in Game Design, Advice from the International Game Developers Association (IGDA) on Choosing an Academic Game Program, Publisher's Team, Team Profile, All Contribute to the Design, Team Building, Team Communication, Conclusion, Further Reading.	**3**
13	**Stages of Development:** Stages Defined, From Classroom to Console: Producing flow for the PlayStation, How to Make a Project Plan, Business Opportunities for Independents, Conclusion, Designer Perspective: Stan Chow, Designer Perspective: Starr Long, Further Reading.	**3**
14	**The Design Document:** Communication and the Design Document, Contents of a Design Document, Table of Contents Writing Your Design Document, Indie Game Jam: An Outlet for Innovation and Experimental Game Design, Conclusion, Further Reading.	**3**
		Total Hours: 42

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Data Structures) (10B11CI211)	**Level of Attainment**	**PO- 1**	**PO- 2**	**PO- 3**	**PO- 4**	**PO- 5**	**PO- 6**	**PO- 7**	**PO- 8**	**PO- 9**	**Weigh t age**
1. To gain knowledge of the role of the Game	Familiarity	H	M	H	L	M	H	H	M	L	74%
2. To have exposure to structure of game	Familiarity	H	H	H	L	M	H	H	H	M	85%
3. To have hands-on skills to work with formal elements of game design	Computatio nal skills	H	H	H	L	M	H	M	H	M	84%
4. To have hands-on skills to Working with Dramatic Elements.	Assessment	H	H	H	H	M	H	H	M	M	88%
5. To have hands-on skills to Working with System Dynamics	Assessment	H	H	H	M	M	H	H	H	M	92%
6. To acquire knowledge of conceptualization	Technical skills	H	H	H	M	M	M	H	M	M	80%
7. To learn game prototyping	Technical	H	H	H	M	M	M	M	M	M	78%

	skills										
8. To gain an understanding of play testing, functionality, completeness, and balance in game design.	Technical skills	H	H	H	H	M	H	H	M	M	92%
9. To have exposure to build teams for computer game designing	Assessment	H	H	H	H	M	H	H	H	M	85%
Weightage		100%	96%	96%	96%	63%	93%	93%	81%	63%	

Methodology:

Teaching in this course is designed to engage the students in active learning by taking a problem solving and design-oriented approach with special emphasis on real-world applications. Students are expected to know the basics of computer game design to carry out a lot of design for solving a problem.

Evaluation scheme:

Mid Sem-1	– 15 marks	
Mid Sem-2	– 25 marks	
Mid Sem-3	– 35 marks	
Internal Assessment(Assignments/Quizzes/attendance)		– 25 marks
Total	**100 marks**	

Suggested Readings

The following background readings provide more detailed coverage of the course material:

Text Book(s)

- Game Design Workshop, 3rd Edition: A Playcentric Approach to Creating Innovative Games is a book on game design by Tracy Fullerton, originally published by CMP Books.

Reference Book(s)

- **A Theory of Fun for Game Design, by Koster.** This book shows the similarities between game design and education, with a good discussion of the concept of Flow. Half text and half cartoons, this short book flows nicely and can be read in the afternoon or two.
- **Understanding Comics: The Invisible Art, by McCloud**. While this book claims to be about comics, many of the lessons within can be applied to game design and other forms of art. It also happens to be a comic book itself, and fun to read.

Annexure-II

Course Description of "Real World Applications of Algorithms"

Course Credits: 3 (3-0-0)

Course description and Objective and Outcomes of the Course

This course covers how algorithms and theory are used in "real-world" applications. The course will cover both the theory behind the algorithms and case studies of how the theory is applied.

The objective of the course:

Interesting algorithms arise in many real world applications in a broad variety of areas. Getting a better understanding of where and how these algorithms are used can be valuable in many ways. It can help in the teaching of algorithms by supplying up-to-date examples of the contexts in which algorithms are used. It can help make effective use of algorithms in the industry by allowing better sharing of experiences. It can help motivate new problems to consider or can improve our understanding of the models and the assumptions we make in various problem domains. It can give us a better feeling of what it takes to have industry use algorithms, and it can help us better understand what factors are important in the design of algorithms.

Outcomes:

Students will learn:

- What is the process of getting algorithms used in the real world?
- How important are constants and how important are asymptotics in practice?
- Are there application domains in which algorithms should be playing a larger part?
- How do we deal with the tension between (a) creating broadly useful algorithms for generic problems, and (b) meeting the needs of a specific client?
- The real world is noisy. How should algorithms deal with noisy input data?

Following topics will be covered:

Topics		HRS
1	**Compression:** Information Theory. Huffman/Arithmetic/Gamma Codes. Context Coding/PPM. Lempel Ziv/Gzip/Burrows Wheeler. Graph Compression.	5
2	**Linear and Integer programming:** Flow problems as Linear programs. Simplex, Ellipsoid, and Interior point methods. Reductions to integer programs. Basic techniques for solving integer programs. Airline crew scheduling.	5
3	**Cryptography:** One-way functions, basic protocols. Number theory review: groups, fields, Galois fields. Private key cryptosystems (Block Ciphers, Rijdael. Public key cryptosystems	5

	(SSL, RSA, ElGamal, Diffie-Hellman), Kerberos and Digital Cash.	
4	**Error Correcting Codes:** Hamming Codes, Linear Codes. Reed Solomon Codes, Cyclic Codes. Expander graphs and Tornado codes.	**5**
5	**Dimensionality Reduction:** Random Projections and Johnson-Lindenstrauss. Singular-Value Decompositions. Compressive Sensing.	**5**
6	**Computational Biology:** Approximate String Matching. Various gap and cost models. BLAST/FAST - Sequencing the Human Genome.	**5**
7	**Satisfiability:** Proof Systems, Resolution**.** DPLL type algorithms, with advanced features (clause learning, backtracking heuristics, ...). Local-search based methods. Reduction strategies to encode your problems as SAT instances.	**5**
8	**Computational Geometry:** Polygon Triangulation: Implementation & Apps. Voronoi Diagram. Delaunay Triangulations: Applications. Robot Motion Planning.	**5**
9	**Miscellaneous applications:**	**2**
		Total Hours: 42

Digital Filter Design and Applications

COURSE CODE: 18B1WEC631

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Signals & Systems Course

Objectives:

1. To understand the basics and practical limitations of digital filter design.
2. To study the digital filters applications.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Understand the basics of the digital Filters	Familiarity
CO-2	Design and analysis of the FIR filters	Usage
CO-3	Design and analysis of the IIR filters	Usage
CO-4	Understand the limitation of IIR and FIR Filters in implementation	Familiarity
CO-5	Study the applications of digital filters	Assessment

Course Contents:

S. No.	Contents	Contact Hours
1.	Introduction to Filters: Butterworth filters, Chebyshev filters, Elliptical Filters, Bessel Filters, FIR filters, IIR Filters.	10
2.	FIR Filters: One dimensional FIR filter design using rectangular window, triangular window, hamming window, dolph-chebyshev window, and Kaiser window. Two dimensional FIR filter design.	10
3	IIR Filters: One dimensional and two dimensional IIR filter design.	06
4.	Practical Considerations in implementation Coefficient Quantization in Digital Filters, Scaling in Fixed-Point Arithmetic, Quantization Noise.	04
5.	Applications of Digital Filters, Noise suppression, Enhancement of selected frequency ranges, Removal or attenuation of selected frequencies, Bandwidth limiting. Analysis of digital filters for signal and image processing using MATLAB, and LABVIEW.	12
	Total	42

Suggested Text Book(s):

1. Andreas Antoniou, Digital Filters: Analysis, Design and Applications, Second edition, Tata Mc Graw Hill, 1999.
2. M. Ahmadi, M. Azimi-Sadjadi, R. Gorgui-Naguib, R. King, A. Kwabwe,Digital Filtering in One and Two Dimensions, 1st Edition, Springer Science & Business Media, 1989.

3. Jackson, Leland B. Digital Filters and Signal Processing: with MATLAB®Exercises. Springer Science & Business Media, 2013.

Suggested Reference Book(s):

1. Wu-Sheng Lu, Two-Dimensional Digital Filters, 1st Edition, CRC Press, 2001.
2. Winder, Steve, Analog and digital filter design, 2nd Edition, Newness Publishers, 2002
3. Schaumann, Rolf, Haiqiao Xiao, and Van V. Mac. "Design of Analog Filters 2nd Edition (The Oxford Series in Electrical and Computer Engineering)." (2009).
4. C. Britton Rorabaugh, "Digital Filter Designer's Handbook: With C++ Algorithms",2nd,Volume1, McGraw-Hill, 1997
5. Jolyon M.DeFreitas, Digital Filter Design and solutions, Artech house publishers, 2005
6. Andreas Antoniou, Digital Filters: Analysis, Design and Applications, Second edition, Tata Mc Graw Hill, 1999
7. Taylor, Fred. Digital filters: principles and applications with MATLAB. Vol. 30. John Wiley & Sons, 2011.

Other useful resource(s):

1. https://ocw.mit.edu/resources/res-6-008-digital-signal-processing-spring-2011/video-lectures/lecture-17-design- of-fir-digital-filters/, I Prof. Alan V. Oppenheim
2. http://web.stanford.edu/class/archive/ee/ee264/ee264.1072/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Digital Filter Design and Applications)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	3	2	2	1	1	1	1	3	1	1	1.8
CO-2	3	3	3	3	3	1	1	1	2	2	2	2	2.2
CO-3	3	3	3	3	3	1	1	1	2	2	2	3	2.3
CO-4	3	3	3	3	3	3	3	3	3	2	2	2	2.8
CO-5	3	3	3	3	3	3	3	3	3	2	2	1	2.7
Average	3	3	3	2.8	2.8	1.8	1.8	1.8	2.2	2.2	1.8	1.8	

ELECTROMAGNETIC ENGINEERING

(Core Subject)

Course Code:	17B11EC411	**Semester:**	4th Semester, B. Tech (ECE)
Credits:	4	**Contact Hours:**	L-3, T-1, P-1

Course Objectives

1. To provide the basic skills required to understand, develop, and design various engineering applications involving electromagnetic fields.
2. To lay the foundations of electromagnetism and its practice in modern communications such as wireless, guided wave principles such as fiber optics and electronic electromagnetic structures.

Course Outcomes

After study through lectures and assignments, students will be able to:

1. Apply vector calculus to static electric-magnetic fields in different engineering situations.
2. Analyze Maxwell's equation in different forms (differential and integral) and apply them to diverse engineering problems.
3. Examine the phenomena of wave propagation in different media and its interfaces and in applications of microwave engineering.
4. Analyze the nature of electromagnetic wave propagation in guided medium which are used in microwave applications.

Course Contents

Unit	**Topics**	**References (chapter number, page no. etc)**	**Lectures**
1.	Vector Calculus and Co-ordinate systems: Scalar and Vector product, Line, surface and volume integral, Gradient, Curl and Divergence, Rectangular, Cylindrical and Spherical co-ordinate systems.	Dr. Sunil Bhooshan	5
2.	Electrostatics: Coulomb's law, Electric field, electric field due to point charges, dipole, infinite line charge and infinite sheet charge, Electric displacement and electric flux density, electric potential, equipotential surfaces, potential energy, current density, continuity equation, Capacitance, boundary conditions, Laplace and Poisson's equations.	William H.Hayat	10
3	Magnetostatics: Bio-Savart law, Ampere's law, Magnetic field, Magnetic scalar potential ,Magnetic vector potential, Magnetic flux density, Lorentz force, Electron moving in a steady magnetic field, A straight wire carrying a	William H.Hayat	7

	current in a magnetic field, Force between two current elements, Inductance and mutual inductance.		
4	Time dependent fields and Electromagnetic waves: Time dependent Maxwell's equations (Differential and Integral form), Time and Frequency domain wave equations, wave polarization (Circular and Elliptical), Boundary conditions, Reflection and Refraction of waves, Pointing vector and Poynting theorem.	William H.Hayat	11
5	Transmission Lines and Wave guides: Time domain and Frequency Domain transmission line equations, Solution of transmission line equation, Standing wave ratio, λ/8, λ/4, λ/2 transmission line, transmission line charts, Parallel Plate waveguide, Rectangular and Circular waveguides.	David M. Pozar	9
		Total Number of Lectures	**42**

Evaluation Scheme

1. Test 1 : 15 marks
2. Test 2 : 25 marks
3. Test 3 : 35 marks
4. **Internal Assessment** : 25 marks
   - 10 Marks : Class performance, Tutorials & Assignments
   - 10 Marks : Quizzes
   - 5 marks : Attendance

Text Books

1. Prof. Dr. Sunil Bhooshan, 'Fundamentals of Engineering Electromagnetics', Oxford University press, 2012.
2. William H.Hayat and J. A.Buck, 'Engineering Electromagnetics',7thed, Tata McGraw Hill.
3. David M. Pozar, 'Microwave Engineering', 4thed, John Wiley & Sons.
4. C.A.Balanis, 'Antenna Theory',3rded, John Wiley & Sons.

Reference Books

1. Jordan Balmin, 'Electromagnetic waves and Radiating Systems'.
   M. Sadiku, 'Elements of Electromagnetics'.

Embedded System Design

COURSE CODE:

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite:

None

Course Objectives:

To learn about the embedded system application areas, design challenges, design and development methodology, tools used for embedded system design, embedded system integration and testing.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Understand various components of embedded system, design challenges and design metrics	Familiarity
CO-2	Learn about embedded system programming through 8051 microcontroller, programming and I/O interfacing	Usage
CO-3	Comprehend RISC architecture, programming of ARM and PIC microcontrollers	Usage
CO-4	Know about embedded system design and development methodology, tools and languages used for embedded system design	Usage
CO-5	Learn about integration and testing of embedded systems	Assessment

Course Contents:

Unit	Contents	Lectures Required
1	Introduction: Embedded systems overview, Classification, Application areas, Design challenges – real-time execution, physical size, power consumption, multirate operation. Design metrics – time-to-market, unit cost, performance.	4
2	Typical Embedded System: Core of the embedded system, Sensors and actuators, Communication interface, Embedded firmware	6
3	8051 Microcontroller: 8051 Architecture, timers and interrupts, Special function registers, Program/ data memory, addressing modes. instruction set, interrupts,	8
4	ARM Processor Fundamentals and Architectures, ARM Instruction Set, PIC Microcontroller and its Architecture.	10
5	Design and Development of Embedded product: Analog Electronic Components, Digital Electronic Components, Electronic design automation tools, Embedded firmware design approaches, Embedded firmware development languages	8

6	Integration and testing of embedded hardware and firmware, Embedded system development environment, Product enclosure design and development, Embedded product development life cycle, Trends in embedded industry	6
Total		42

Suggested Text Book(s):

1. Frank Vahid and Tony Givargis, “Embedded system design: A unified Hardware/Software introduction,”3rd Ed., Wiley 2014
2. Shibu K. V, “Introduction to Embedded Systems,” 2nd Ed., McGraw Hill, 2017

Suggested Reference Book(s):

1. Steve Furber, “ARM System-on-Chip Architecture,” 2nd Ed., Pearson 2012
2. Tim Wilmshurst, “Designing Embedded Systems with PIC Microcontrollers: Principles and Applications,” 2nd Ed., Newnes, 2009
3. Steven F Barrett and Daniel J Pack, “Embedded Systems Design and Applications with the 68HC12 and HCS12,” 1st Ed., Pearson 2012
4. Kenneth Ayala, “The 8051 microcontroller,” 3rd Ed., Thomson, 2005

Other useful resource(s):

NPTEL ONLINE COURSES

1. Embedded Systems: https://nptel.ac.in/courses/108105057/ (Prof. A. Routray, Prof. Rajib Mall, Prof. Amit Patra, IIT Kharagpur)
2. Embedded Systems: https://nptel.ac.in/courses/108102045/ (Prof. Santanu Chaudhary, IIT Delhi)
3. Embedded Systems Design: https://nptel.ac.in/courses/106105159/ (Prof. Anupam Basu ,IIT Kharagpur)

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

CO/PO (Embedded System Design)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Average
CO1	2	X	2	1	2	X	X	X	X	X	3	1	0.92
CO2	3	3	3	2	3	2	X	X	2	3	X	3	2.00
CO3	3	2	3	2	3	2	X	X	1	2	X	2	1.67
CO4	3	2	3	2	3	2	X	X	1	X	X	2	1.50
CO5	3	2	3	2	3	2	X	X	X	X	X	2	1.42
CO6	3	2	3	2	2	3	X	X	2	2	1	1	1.75
Average	2.83	1.83	2.83	1.83	2.67	1.83	0.00	0.00	1.00	1.17	0.67	1.83	

Human Rights for Technocrats

COURSE CODE: 18B1WHS641

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

1. Develop an understanding of what human rights are and to understand the origins of modern human rights
2. Appreciate the meaning and significance of the Universal Declaration of Human Rights and other human rights instruments
3. Appreciate the relationship between rights and responsibilities
4. Understand the forms human rights can take, legally and morally
5. Analyze the relationship of human rights to daily life and apply the concepts of human rights to their own lives.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Develop an understanding of what human rights are and to understand the origins of modern human rights	Familiarity
CO-2	Appreciate the meaning and significance of the Universal Declaration of Human Rights and other human rights instruments	Usage
CO-3	Appreciate the relationship between rights and responsibilities	Familiarity
CO-4	Understand the forms human rights can take, legally and morally	Familiarity
CO-5	Analyze the relationship of human rights to daily life and apply the concepts of human rights to their own lives.	Usage

Course Contents:

Unit	Contents	Lectures required
1	**Conceptual background of human rights and duties:** Definitions and classifications	**2**
2	**Meaning and Significance of Human Rights :** Scope of the Human Rights	**2**

3	**Relationship between Rights and Duties:** Constitutional provisions, Fundamental rights, Directive Principles of state policy, Duties of individuals and Fundamental duties	**4**
4	**Universal Declaration of Human Rights: Technical background :** Creation and drafting, Adoption, Significance of the UDHR, And its legal effect	**5**
5	**History of human rights civilization:** Brief history of human Rights**,** The Spread of Human Rights, Middle Ages, Modern human rights	**5**
6	**Human rights movements :** Anti-colonialism, World War II and the United Nations, Global human rights struggles, Changes in the 1970s Since the 1990s	**8**
7	**Enforcement and protection mechanism of human rights in India :** Judiciary, National Human Rights Commission and other Commissions and Committees , Non-governmental organizations, Information Media, Education	**5**
8	**Development, international trade and human rights:** Right to development: Issues of international equity and justice, equitable access to benefits of science and technology, Freedom of international trade, most-favoured nation treatment (equality of treatment) versus special treatment of the developing countries, access to international markets, equitable pricing of raw material	**5**
9	**Human rights, science and technology:** Overview,violation of human rights by technology	**3**
10	**Human rights of the working class:** Labour welfare legislation in India, Problems of bonded labour, exploitation of child labour, female labour and unorganized labour	**4**
Total lectures		**42**

Suggested Text Book(s):

1. Internet and human rights Griffin, J. (2008) On Human Rights. Oxford: Oxford University Press.
2. Miller, D. (2007) National Responsibility and Global Justice. Oxford: Oxford University Press

Suggested Reference Book(s):

1. Internet and human rights Griffin, J. (2008) On Human Rights. Oxford: Oxford University Press.
2. Miller, D. (2007) National Responsibility and Global Justice. Oxford: Oxford University Press

Other useful resource(s):

1. https://www.google.com/search?q=Meaning+and+Significance+of+Human+Rights&rlz=1C1GCEU_enBIN820IN820&oq=Meaning+and+Significance+of+Human+Rights&aqs=chrome..69i57j0l5.1710j0j7&sourceid=chrome&ie=UTF-8
2. https://www.equalityhumanrights.com/en/human-rights/what-are-human-rights

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (5) - 10 Presentation (1)- 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Human Rights for Technocrats)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	0	0	3	0	0	3	3	3	3	3	0	3	1.75
CO-2	0	3	0	3	0	3	3	3	3	3	0	3	2
CO-3	0	0	0	3	0	3	3	3	3	3	0	3	1.75
CO-4	0	0	0	0	0	3	3	3	3	3	0	3	1.5
CO-5	0	3	0	0	0	3	3	3	3	3	0	3	1.75
Average	0	1.2	0.6	1.2	0	3	3	3	3	3	0	3	

Information Systems Lab

COURSE CODE: 18B17CI572

COURSE CREDITS:2

CORE/ELECTIVE: CORE

L-T-P: 0-0-4

Pre-requisite: None

Course Objectives:

1. Understand various technologies and processes available for developing business software.
2. Study and understand underlying infrastructure of information systems.
3. Learn to identify and analyze requirements for information systems.
4. Develop proficiency in structuring, collecting, and analyzing data to support business operations and strategic decision making.
5. Understand and apply design principles in Information Systems.
6. Demonstrate proficiency in selecting, implementing and operating information technology solutions to meet organizational requirements.
7. Develop an understanding of the social issues and ethical implications of technology across organizations and society.
8. Develop a proficiency in the selection of tools, techniques, processes, and success factors related to effective management of IT projects.
9. Develop proficiency in business reporting and strategic analysis of data.

Course Outcomes:

S.No.	Course outcomes	Level of Attainment
CO-1	To analyze how IT provides value by improving the management process through access to better information.	Familiarity
CO-2	To understand and apply system development and project management principles.	Familiarity and usage
CO-3	To acquire knowledge of various information system development technologies.	Usage
CO-4	To have hands on skills to evaluate Servlet technology for information development.	Assessment
CO-5	To have hands on skills to evaluate JSP technology for information development.	Assessment
CO-6	To develop the ability to evaluate information systems, assess user needs, propose solutions, and evaluate proposals for implementation.	Assessment

List of Experiments

S.No	Description	Hours
1	Understanding Existing Information Systems	**2**
2	Building MVC based solution in Java, java Servlets	**6**
3	Implement Java Server pages	**6**
4	Implement Stateless EJB	**6**
5	Build Stateful EJB	**4**
6	Implementing Container Managed Persistence EJB	**4**
7	Design Bean Managed Persistence EJB	**4**
8	Implement XML based SOAP	**4**
9	Implement blog website using Java Server pages	**4**
10	Building Thin & Thick client MVC based solution in Java	**4**
11	Implement Java based cryptography technique	**4**
12	Show use of DSS in decision making process	**4**
13	Understanding Executive Information Systems (EIS)	**2**
14	ImplementingTransaction Processing Systems	**2**
Total lab hours		**56**

Suggested Books/Resources:

1. Rafael L. Alcami, Carlos D. Caranana, “Introduction to Management Information Systems”.
2. Marty Hall, Larry Brown, “Core Servlets and Java Server Pages”, Prentice Hall
3. Ethan Cerami, “Web Services Essentials”, O’Reilly
4. Kogent, “Java Server Programming tutorial, J2EE Black Book”, Dreamtech Press
5. Herbert Schildt, “The Complete Reference: JAVA”, Tata McGraw- Hill
6. Kathy Sierra & Bert Bates, “Head First EJB”, O’Reilly
7. Phil Hanna, “The Complete Reference: JSP 2.0” Tata McGraw-Hill
8. Stefan B. Harsh, “Management Information Systems”

EvaluationScheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Attendance	15 Marks
4	Lab Assessment	45 Marks
	Total	100 marks

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Average
CO-1	3	3	2	1	2	2	2	1	2	3	3	2	**2.2**
CO-2	3	3	3	2	2	2	3	2	2	1	2	2	**2.3**
CO-3	3	3	2	1	1	3	3	3	3	3	1	1	**2.3**
CO-4	3	2	2	1	2	2	2	2	1	2	1	2	**1.8**
CO-5	3	2	2	1	2	3	3	2	1	3	2	1	**2.1**
CO-6	3	3	2	1	1	3	3	1	3	3	3	1	**2.3**
Average	**3**	**2.7**	**2.2**	**1.2**	**1.7**	**2.5**	**2.7**	**1.8**	**2**	**2.5**	**2**	**1.5**	

LINEAR INTEGRATED CIRCUITS
(Core Subject)

Course Code:	17B11EC511	**Semester:**	Semester 5th, B. Tech (ECE)
Credits:	4	**Contact Hours:**	L-3, T-1, P-0

Course Objective

1. Acquire knowledge about basic building blocks of an operational amplifier and its terminal characteristics.
2. Acquire knowledge about linear and nonlinear circuits and their applications.
3. Foster ability to identify basic requirements for designing any application using linear integrated circuits.
4. Foster ability to understand the use of linear integrated circuits in commercial and industrial applications.

Course Outcomes

1. Ability to understand the terminal characteristics of op-amps and design /analyze fundamental circuits based on op-amps.
2. Understanding of various parameters and interpretation of data sheets for Op-Amp.
3. Ability to analyze and design various applications like amplifiers, active filters, wave generators, wave shaping circuits, A/D and D/A convertors using Op-Amp.
4. Design and analysis of various applications using 555 timer.

Course Contents

Unit	Topics	References (chapter number, page no. etc)	Lectures
1.	**Introduction to Op-Amp and its characteristics.** Linear Integrated Circuits Differential Amplifiers Basic of Differential Amplifier, Transistorized differential Amplifier, Configurations of Differential Amplifier, Analysis of Dual Input Balanced Output Differential Amplifier, Constant Current Bias, Current Mirror Circuit, Cascading of Differential Amplifiers.	Chapter 1, 2 & 3: OP-AMPS & Linear Integrated Circuits. Fourth Edition R A Gayakwad	7
2.	**Op-Amp characteristics and frequency response** Op –Amp packaging type, pin configuration, Op-Amp basics, Op-Amp specifications, DC offset parameters, Frequency parameters, Unit	Chapter 4 & 5: OP-AMPS & Linear Integrated Circuits. Fourth Edition R A Gayakwad	5

	specifications, offset voltages and currents, virtual Ground, slew rate, CMRR, PSRR, Gain bandwidth product etc.		
3.	**General linear applications.** DC & AC Amplifiers, Peaking Amplifier, Summing, Scaling and Averaging amplifier, Instrumentation Amplifier, Voltage-to-Current Converter, Current to-Voltage Converter, The Integrator, The Differentiator, Log and Antilog Amplifier, Peak Detector, Precision Rectifiers, Comparator, Zero Crossing Detector, Schmitt Trigger, Sample and Hold Circuit, Clippers and Clampers, A/D and D/A Converters.	Chapter 6 OP-AMPS & Linear Integrated Circuits. Fourth Edition R A Gayakwad	8
4.	**Active Filters** Butterworth Filters, Band-Pass Filters, Band Reject Filters, All Pass Filters, Universal Active Filter.	Chapter 7 OP-AMPS & Linear Integrated Circuits. Fourth Edition R A Gayakwad	6
5.	**Wave Shaping Circuits** Multi-vibrators (Astable, Mono-stable, Bi-Stable), High pass and low pass filters using R-C Circuits and R-L, R-L-C Circuits & their response to step input, Pulse input, Square input and Ramp Input, Attenuators, Clamping Circuit theorem, Clipping and Clamping circuits, Schmitt Trigger, Comparator.	Chapter 8 OP-AMPS & Linear Integrated Circuits. Fourth Edition R A Gayakwad	8
6.	**Specialized IC Applications** Voltage-Controlled Oscillator (VCO), Square Wave Generator, Triangular Wave Generator, Saw-tooth Wave Generator, The 555 Timer, Monostable and Astable Multivibrator using IC 555, Phase-Locked Loop (PLL), Voltage Regulators.	Chapter 9 OP-AMPS & Linear Integrated Circuits. Fourth Edition R A Gayakwad	8
Total number of Lectures			42

Evaluation Scheme

1. Test 1 :15 marks
2. Test 2 : 25 marks
3. Test 3 : 35 marks
4. **Internal Assessment** : 25 marks
    - 10 Marks : Class performance, Tutorials & Assignments
    - 10 Marks : Quizzes

- 5 marks : Attendance

Text Books

1. R.A. Gayakwad, Op Amp and Linear Integrated Circuits, Fourth edition, earson Education .
2. Robert F. Coughlin & Frederick F. Driscoll, Operational Amplifiers and Linear Integrated Circuits, 6th edition, Pearson, 2000.

Reference Books

1. Adel S. Sedra, Kenneth C. Smith : Microelectronics Circuits, 5th Ed., Oxford University Press, 2004

LINEAR INTEGRATED CIRCUITS LAB

(Core Subject)

Course Code:	17B17EC571	Semester:	5th Semester, B. Tech (ECE)
Credits:	1	Contact Hours:	L-0, T-0,P-2

Course Objectives

1. Familiarize the students with linear integrated circuits (IC 741, IC555).
2. In depth knowledge of applying theoretical concepts on circuit design applications.
3. To provide experience in handling integrated circuits and design hardware applications using linear ICs on bread board.
4. To introduce the students to software (PSPICE) using which they can simulate various circuits based on linear ICs.
5. Impart ability to handle the apparatus and trouble shoot various linear circuit applications.

Course Outcomes

1. Ability to use Op- amp IC 741 to design various applications like amplifiers, comparator, active filters and waveform generator etc.
2. Ability to simulate various circuits using IC741 and IC 555 in PSPICE for DC bias point and AC sweep settings.
3. Experience to identify problems and troubleshoot various linear and nonlinear circuits.
4. Ability to handle the apparatus required to design linear circuit applications.

List of Experiments

1. Design of Inverting and Non-Inverting Amplifiers using OPAMP.
2. Design of Adder and Subtractor circuits using OPAMP.
3. Design of Integrator and Differentiator using OPAMP.
4. Design and simulate triangular/square waveform generator using IC 741.
5. Design and simulate voltage regulator using op-amp.
6. Design and simulate Frequency response of 1st order HPF and LPF filter.
7. Design and simulate Schmitt trigger using IC 741 for given values of UTP and LTP.
8. Design and simulate monostable multivibrator for required pulse width using IC 741.
9. Design and simulate astable multivibrator for required frequency and duty cycle using IC 741.
10. Design and simulate of RC oscillators for required frequency.

Evaluation Scheme

1.	Mid Sem Evaluation	20 Marks
2.	End Sem Evaluation	20 Marks
3.	Attendance	20 Marks

4. Class response	20 Marks
5. File	20 Marks
Total Marks	**100 Marks**

Text Books

1. Op-Amps And Linear Integrated Circuitsby R. A. Gayakwad

MICROWAVE DEVICES AND ANTENNA DESIGN

(Core Subject)

Course Code:	17B11EC512	**Semester:**	5th Semester, B. Tech (ECE)
Credits:	4	**Contact Hours:**	L-3, T-1, P-2

Course Objectives

At the completion of this course, the student should have knowledge of the applications of Electromagnetics in microwave devices, basic antenna systems and antenna arrays.

Course Outcomes

After the successful completion of the course student should be able to:

1. Learn the applications of Electromagnetics applied to variety of Microwave Devices and Antenna Systems and their properties.
2. Analyze the nature of electromagnetic wave propagation in guided medium which are used in microwave applications.
3. Know the operating principles of microwave devices and their characteristics measurements.
4. Integrate various disciplines in electromagnetic so that the student appreciates microwave devices and antennas from a system standpoint.
5. Familiarize the student with the procedure of designing simple antennas and array design.
6. At the conclusion of the course, the student should have a far greater capacity to read and understand technical articles such as those seen in the IEEE Transactions Microwave theory and techniques and also on IEEE Transaction on Antennas and Propagation to use them in real time applications.

Course Contents

Unit	Topics	References (chapter number, page no. etc)	Lectures
1.	Introduction to Microwaves: Frequency allocations, Microwave waveguide, Rectangular waveguide and its analysis, circular waveguide, modes of propagation, dominant modes, cut off wavelength, mode excitation.	Pozar	5
2.	Microwave Generators And Amplifiers: Reflex klystron, two cavity and multi cavity klystron amplifiers and oscillators, basics of Magnetrons and traveling wave tubes and their applications.	Liao	8
3	Microwave Devices: Scattering matrix of microwave waveguide junction, properties of S-	Pozar	8

	matrix, E-plane tee, H-plane tee, magic tee, attenuators, directional couplers, ferrite devices, Faraday rotation, gyrator, isolator, circulators and cavity resonators, Gunn diode and its modes of operation.		
4	Antenna Basics: Directional properties of antennas, Radiation patterns, antenna gain and aperture, antenna terminal impedance, self and mutual impedance, front to back ratio, antenna beam width and bandwidth, antenna efficiency, antenna beam area, polarization, antenna temperature and reciprocity properties of antennas.	R.S.Elliot	6
5	Antenna Arrays: Classification of arrays, linear arrays of two point sources, linear arrays of n-point sources, pattern multiplication, array factor, linear arrays of equal amplitude and spacing (Broadside and end fire arrays), directivity and beam width Chebyshev arrays, Introduction to planar arrays.	R.S.Elliot	6
6	Special Antennas: VLF and LF antennas (Hertz and Marconi antennas), receiving antenna and radio direction finders. Folded dipole antennas, Yagi-uda antenna, horn antennas, microwave dish, helical antennas, microstrip antennas.	Ballanis	9
		Total Number of Lectures	42

Evaluation Scheme

1. Test 1 :15 marks
2. Test 2 : 25 marks
3. Test 3 : 35 marks
4. **Internal Assessment** : 25 marks
    - 10 Marks : Class performance, Tutorials & Assignments
    - 10 Marks : Quizzes
    - 5 marks : Attendance

Text Books

1. Pozar, David M. *Microwave engineering*, John Wiley & Sons, 2009.

2. Liao, Samuel Y. *Microwave solid-state devices*. Prentice Hall, 1985.

3. Elliot, Robert S. *Antenna theory and design*. John Wiley & Sons, 2006.
4. Ballanis, Constantine A. "Antenna theory analysis and design." *John Willey and Son's Inc., New York* (1997).

Reference Books

1. Jordan, E. C., and K. G. Balmain. *Electromagnetic Waves and Radiating Systems*, Prentice Hall." *Englewood Cliffs, New Jersey* (1968).
2. Robert E.Colin. *Foundations for Microwave Engineering*, McGraw Hill, 2nd Edition, 2001.
3. John D. Kraus & R.J Marhefka, *Antennas for all appl*ications, The McGraw-Hill Companies, 2nd/3rd edition, 2006
4. C.A. Balanis*, Antenna Theory, Analysis and Design*. NY: John Wiley and Sons, 2nd edition, 2002
5. WL Stutzman & GA Thiele, Antenna Theory and Design , John Wiley and Sons, 2nd edition,1997

Network Analysis and Synthesis

COURSE CODE: 18B1WEC534

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

1. Circuit analysis in the S domain using Laplace transforms. Analysis of two port networks.
2. Design and analysis of filters and attenuators. Elements of realizability and synthesis of one port networks.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Understand the need and foundation of network analysis	Familiarity
CO-2	Analyze two port networks, filters and attenuators	Assessment
CO-3	Analysis of problem solving, knowledge and reasoning	Assessment
CO-4	Study of application domains for network analysis and synthesis.	Usage

Course Contents:

Unit	Contents	Lectures required
1	Laplace transform and its application in circuit analysis : Laplace Transformation, laplace transforms of some important functions, properties of laplace transforms, step function, impulse function, laplace transform of periodic functions, inverse transforms, initial and final value theorms. Circuit elements in the S domain, Transfer function, use of transfer function in circuit analysis, the transfer function and the convolution integral, the transfer function and the steady state sinusoidal response, the impulse function in circuit analysis.	8
2	S- Domain Analysis: Concept of complex frequency, physical interpretation of complex frequency, transform impedance and transform circuits, series and parallel combinations of elements, terminal pair or ports, network function for one port and two port networks, poles and zeros of network functions, significance of poles and zeros, properties of driving point functions, properties of transfer functions, necessary condition for a driving point function, necessary condition for transfer functions, time domain response from pole zero plot, amplitude and phase response from pole zero plot, stability criteria for an active network, routh criteria.	9
3	Two- Port networks: Two port networks, open circuit (Z) parameters, short circuit (Y) parameters, transmission (ABCD) parameters, inverse transmission (A' B'C'D')parameters, Hybrid (H) parameters, Inverse Hybrid(G) parameters, inter relationships of different parameters, interconnection of two port networks, T and ∏ representations, terminated two port network, lattice network, Image networks.	8
4	Filters and Attenuators: Classification of filters, filter networks, equation of filter networks, classification of pass band and stop band, characteristic impedance in the pass band and stop bands, constant –K low pass filter, constant –K high pass filter, m derived T- section, band pass filter, band elimination filter, attenuators, T- type attenuator, ∏- type attenuator, lattice attenuator, bridged –T attenuator, L- type attenuator, equalizers, inverse network, series equalizer, full series equalizer, shunt equalizer, full shunt equalizer, constant – resistance equalizer, bridged –T attenuation equalizer, bridged –T phase equalizer, lattice attenuation equalizer, lattice phase equalizer.	9
5	Elements of realizability and synthesis of one port networks : Hurwitz polynomials, positive real functions, frequency response of reactive one ports, synthesis of reactive one ports by foster's method, synthesis of reactive one ports by Cauer's method, synthesis of R-L network by foster's method, synthesis of R-L network by Cauer's method, synthesis of R-C network by foster's method, synthesis of R-C network by Cauer's method.	8
Total lectures		42

Suggested Text Book(s):

1. A sudhakar, shyammohan S palli" Circuits and networks Analysis and synthesis", Fifth Edition, Tata Mcgraw Hill.
2. M E Van Vakenburg,"Network Analysis and synthesis", Third edition, Pearson

Suggested Reference Book(s):

1. Ravish R Singh, "Network Analysis and synthesis", Tata Mcgraw Hill.

Other useful resource(s):

Link to topics related to course: https://nptel.ac.in/courses/106105154

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Network Analysis and Synthesis)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	2	3	3	3	1	1	1	2	2	2	2	2.08
CO-2	2	3	2	3	2	1	1	1	2	2	1	2	1.83
CO-3	2	3	3	2	2	1	1	1	2	2	1	2	1.83
CO-4	2	3	3	3	2	1	1	1	2	3	1	2	2.00
Average	2.25	2.75	2.75	2.75	2.25	1	1	1	2	2.25	1.25	2	

17B1WHS731 QUALITY MANAGEMENT

Course Goal

Quality management is a system that serves to control Quality in the critical activities of an organization by bringing together resources, equipment, people and procedures. It uses techniques and principles such as quality function deployment, Taguchi method, service quality management, quality audits and Six Sigma to control quality in every sphere of activity in an organization.

Course Objective

1. Evaluate the principles of quality management and to explain how these principles can be applied within quality management systems.
2. Identify the key aspects of the quality improvement cycle and to select and use appropriate tools and techniques for controlling, improving and measuring quality.
3. Critically appraise the organisational, communication and teamwork requirements for effective quality management
4. Critically analyse the strategic issues in quality management, including current issues and developments, and to devise and evaluate quality implementation plans

Detailed Syllabi

Lecture-wise Breakup

Subject Code	17B11WHS731		**Semester**	8
Subject Name	Quality Management			
Credits	3		**Contact Hours**	3
Faculty (Names)	**Coordinator(s)**	1.Dr. Tanu Sharma		
	Teacher(s) (Alphabetically)			
Module No.	**Subtitle of the Module**	**Topics**		**No. of Lectures**

Unit	Contents	Topic	Hrs
1	The Engineer and QM link	Introduction The engineer as a specialist The failure of engineering: educational systems: The UK experience The new breed of engineers Engineers' competences and the role of QM The evolution of engineers for Total Quality Management The engineer in a QM environment	2
2	Pioneers of QM	How old is the quality concept? Why are the Japanese leading the field of quality? How the West has woken up to the importance of quality WE Deming ,Joseph M Juran , Philip B Crosby , Armand V Feingenbaum ,Bill Conway ,Kaoru Ishikawa, Genichi Taguchi , Shigeo Shingo, W G Ouchi	3
3	**Total Preventative Maintenance for QM**	Introduction What is quality? Some quality characteristics The quality processes What is meant by Quality Control? What is meant by Statistical Quality Control? What is meant by Total Quality Control? What is meant by Quality Assurance? What is meant by Quality Management? Some examples of QM models , QM - a boardroom place OM and productivity QM and Advanced Manufacturing Technology	3
4	QM	The meaning of quality systems . Why are Quality Assurance systems needed? The role of quality standards. The different stages of a quality assurance system . The implementation of quality systems . The ISO 9000 quality system British Standard BS *5750/lS0* 9000 . Registration and accreditation in quality systems	4
5	**QM: Tools and Techniques**	Introduction . Why use tools and techniques in QM? How do we define processes? Process variation and its	4

		causes . What are the tools and techniques for QM? Process capability. The implementation of Statistical Process Control	
6	**Total Preventive QM techniques**	Introduction . What is TPM? Failure patterns . Costs and benefits of TPM Some examples of TPM implementation Towards Zero Defect: Zero Breakdown Implementing TPM: Some guidelines	**3**
7	**Continuous Process Improvement- #TQM, Besterfield**	Juran Triology, Improvement Strategies , Types of Problems, The PDCA cycle, Problem solving Methods, Kaizen, Reengineering	**4**
8	**Leadership And Strategic Planning #TQM, Besterfield**	Leadership theory and practices, Creating the leadership system, Strategic Planning, leadership, strategy and organization structure, leadership for Quality ; The Seven Management And Planning tools,	**4**
9	**Essentials of QM**	Introduction Internal customer-supplier chains External customer-supplier chains From customer satisfaction to customer commitment from a win-lose to a win-win situation Towards single sourcing-supplier chains The power of communications in customer-supplier chains.	**3**
10	**Principles of Six Sigma** **#The Management and Control of Quality, Evans Lindsay**	The statistical basis of Six Sigma ; Six Sigma Problem Solving (The DMAIC Methodology ; Tools and Techniques; Design for Six Sigma Six sigma in services and small organizations Six Sigma and Lean Production Lean Six sigma and Services	**3**
11	**Benchmarking**	Define benchmarking, Reasons to benchmark Process, Deciding what to Benchmark, Pitfalls and criticism of Benchmarking	**5**
	Total Hours		**42**

Methodology

The course will be taught with the aid of lectures and case studies. Lectures are combined with hands-on practice and discussion in class. . The students will be provided with research papers which they will analyze and study to further strengthen their understanding of the topics. Students need to read in advance case studies in order to be able to answer the questions. Groupwork outside the classroom is also needed for the students to formulate a strategy for an assigned company.

Evaluation Scheme

Exam	Marks
Test 1	15
Test 2	25
Test 3	35
Case study\presentation	20
Assignment	5

Recommended Reading (Books/Journals/Reports/Websites etc	
1.	Dale H. Besterfield, Pearson, *Total quality Management*, Pearson Education
2.	Evans's. James, Lindsay M. William , *The Management and Control of Quality,* Cengage Learning
3.	H.Lal, Lt. Gen ,Wiley Eastern Limited, 1990 , *Total Quality Management*
4.	Bounds Greg , McGraw , *Beyond Total Quality Management*
5.	Kanishka Bedi, Oxford Higher Education, *Quality Management*
6.	**http://www.evans.swlearning.com**
7.	**www.cengage.com/international**

Advance Communication Lab

COURSE CODE: 18B17EC673

COURSE CREDITS: 1

CORE/ELECTIVE: CORE

L-T-P: 0-0-2

Pre-requisite: None

Course Objectives:

1. Understand the concepts of various digital modulation techniques.
2. To get familiar with the practical implementation of various communication systems.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Understand the basics of LabView, MATLab and WiCOMM-T kit	Familiarity
CO-2	Understand the design, application and practical implementation of various digital modulation techniques.	Usage
CO-3	Gain practical experience of the functioning of advance communication systems.	Usage
CO-4	Analyze the performance of communication systems.	Assessment

List of Experiments

S.No	Description	Hours
1	Introduction to LabView, Matlab and WiComm-T (SDR) kit.	2
2	Implementation of Quadrature Phase Shift Keying Modulation and Demodulation system. • Constellation plots • Phase and frequency offset	2
3	Implementation of Quadrature Amplitude Modulation and Demodulation (QAM) • 16-QAM • 64-QAM	2
4	Implementation of Gaussian Minimum Shift Keying (GMSK) modulation and demodulation system.	2
5	Performance analysis of baseband digital communication link.	2
6	Eye diagram measurement for Inter Symbol Interference (ISI).	2
7	To demonstrate Time Division Multiplexing and Demultiplexing.	2
8	To demonstrate Frequency Division Multiplexing and Demultiplexing.	2
9	Implementation of source coding techniques.	2
10	Implementation of channel coding and error control coding techniques.	2
11	To demonstrate GSM communication system.	2
12	To demonstrate OFDM communication system.	2
Total Lab hours		24

Suggested/Resources:

1. T.S. Rappaport, "Wireless Communication", 2nd Edition, Prentice Hall, 2002.
2. Lazos Hanzo: OFDM and MC-CDMA:a primer, 1st Edition, Wiley-IEEE Press, 2006.

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Attendance	15 Marks
4	Lab Assessment	45 Marks
	Total	100 marks

Approved in Academic Council held on 25.10.2018

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Average
CO1	3	3	2	2	3	2	1	2	1	2	1	3	2.08
CO2	3	3	3	3	3	1	1	1	1	1	1	3	2.00
CO3	3	3	3	3	2	1	1	1	1	2	1	3	2.00
CO4	3	3	3	3	2	1	1	1	1	1	1	3	1.92
Average	3.00	3.00	2.75	2.75	2.50	1.25	1.00	1.25	1.00	1.50	1.00	3.00	

Automatic Control Systems

COURSE CODE: 18B11EC311

COURSE CREDITS: 3

CORE/ELECTIVE: CORE

: 3-0-0

Pre-requisite: Fundamentals of Electrical Circuits

Course Objectives:

1. To understand procedures for developing mathematical models of physical systems, and related analytical and numerical methods for predicting their behavior.
2. To develop the skills of designing compensating networks according to the desired design specifications.
3. To understand and design advance control systems for industrial applications.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	The ability to analyze any physical system using mathematical model.	Familiarity
CO-2	The skill to analyze the response of any LTI system.	Assessment
CO-3	The ability to design control system with desired specifications both in time and frequency domain.	Assessment
CO-4	The ability to derive, interpret and solve problems using modern state space control methods for continuous time and discrete time systems.	Assessment
CO-5	The skill to apply advance control schemes for various applications.	Usage

Course Contents:

Unit	Contents	Lectures required
1	Control System Concepts and Classification: Open loop, Closed loop, Continuous, Discrete, Linear and non-linear control systems	2
2	Mathematical Models of Systems: Laplace and z-transform, Impulse response and transfer function, Block-diagram model and signal flow graphs, Masons gain formula	5
3	Time Domain Analysis: Standard test input signals, Transient and steady state responses of first and second order systems, Steady state errors, Control of transient response, Basic control actions and their effects on transient and steady state responses	7
4	Stability Analysis: Absolute stability, Relative stability, Routh- Hurwitz criterion, Root loci, Properties and construction of root loci, Effects of adding and moving poles and zeros, Root locus of conditionally stable systems	7
5	Frequency Domain Analysis: Frequency response, Frequency domain specifications, Bode and Nyquist plots, Gain margin and phase margin, Conditionally stable system	6
6	Compensator Design: Introduction, Phase lead compensation, Phase lag compensation, Design of phase-lead and phase-lag compensation by Bode plot and root locus methods, Concepts and applications of P, PD, PI and PID controllers	6
7	State Variable Technique: Derivation of state model of LTI continuous time systems, State equations, State transition matrix, Solution of state equations, Stability, Controllability and observability	5
8	Basics of Nonlinear System Analysis: Linearization, Describing function and Phase plane methods, Stability concepts and Lyapunov functions	4
Total lectures		42

Suggested Text Book(s):

1. M. Gopal, “Control Systems: Principle and Design”, 4th Edition, Tata McGraw-Hill, 2012.
2. B.C. Kuo, “Automatic Control Systems”, 9th Edition, Wiley India, 2014.

Suggested Reference Book(s):

1. K. Ogata, "Modern Control Engineering", 5th Edition, Pearson Education, 2010.
2. R.C. Dorf and R.H. Bishop, "Modern Control Systems", 12th Edition, 2007.
3. N. S. Nise, "Control Systems Engineering", 7th Edition, Wiley India, 2013.

Other useful resource(s):

1. Link to NPTEL course contents:https://nptel.ac.in/courses/108102043/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignments (2) - 10 Quizzes(2) -10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Automatic Control Systems)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	2	2	2	2	1	2	1	1	1	1	2	1.7
CO-2	3	2	1	3	2	1	1	1	1	1	1	2	1.6
CO-3	3	3	2	1	2	1	1	1	1	1	1	2	1.6
CO-4	3	3	3	1	2	1	1	1	2	1	1	2	1.8
CO-5	3	2	2	2	3	1	1	1	1	1	1	2	1.7
Average	3	2.4	2	1.8	2.2	1	1.2	1	1.2	1	3	2.4	

Automatic Control Systems Lab

COURSE CODE: 18B17EC371

COURSE CREDITS: 1

CORE/ELECTIVE: CORE

L-T-P: 0-0-2

Pre-requisite: None

Course Objectives:

1. To use computational tools in the modeling, simulation and analysis of control systems.
2. To understand procedures for modeling of physical systems, and related analytical and numerical methods for predicting their behavior.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO1	Understanding of mathematical modeling of electrical-mechanical systems and knowing their behavior.	Familiarity
CO2	The skill to analyze the response of any LTI system using software tools.	Assessment
CO3	The ability to design any system with desired specifications both in time and frequency domain and analyze systems using different techniques.	Assessment
CO4	Design of different types of controller and tuning their parameters to get optimized results.	Usage

List of Experiments

S. No	Description	Hours
1	To determine a transfer function and draw its pole-zero plot for (a) mechanical system (b) electrical system.	2
2	To obtain the overall transfer function of a given complex system represented in either the block diagram representation or signal flow graph representation by using masons gain formula.	2
3	To obtain the time response of a given system and obtain the steady state error for different inputs.	2
4	To obtain the time-domain specifications of a given second order systems for step input.	2
5	To determine the stability of a given LTI system using locations of poles.	2
6	To determine the range of the forward path gain for the system to be stable using root locus technique.	2
7	To design, simulate and analyze the stability and frequency domain specifications of LTI systems using Bode and Nyquist plots.	2
8	To design compensating networks to achieve the desired time domain and frequency domain specifications using (a) root locus and (b) bode plots.	2
9	To design and analyze the state space model of given LTI systems.	2
10	To study and analyze the responses of proportional, proportional derivative, proportional integral and proportional integral derivative controllers.	2
11	To perform Zeigler-Nichols tuning methods for tuning controller parameters.	2
12	To design and analyze state-feedback controller using pole-placement technique (Ackerman's formula).	2

13	To design and analyze a servomechanism control system in Simulink.	2
14	To design and simulate a nonlinear control system and analyze the effects of various nonlinear elements on the system performance.	2
Total Lab hours		28

Suggested Resources:

1. N. S. Nise, "Control Systems Engineering", 7th Edition, Wiley India,2013.
2. K. Ogata, "Modern Control Engineering", 5th Edition, Pearson Education, 2010.

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Attendance	15 Marks
4	Lab Assessment	45 Marks
	Total	100 marks

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Average
CO1	3	2	2	1	3	1	1	1	2	1	1	1	1.58
CO2	3	3	2	2	3	1	1	1	2	1	1	1	1.75
CO3	2	3	2	2	1	1	1	1	2	1	1	1	1.50
CO4	2	2	3	1	1	1	1	1	2	1	1	1	1.42
Average	2.50	2.50	2.25	1.50	2.00	1.00	1.00	1.00	2.00	1.00	1.00	1.00	

Advances in Gene Manipulation

COURSE CODE

COURSE CREDITS: 3

CORE/ELECTIVE: CORE

L-T-P: 3-0-0

Pre-requisite: Molecular Biology

Course Objectives

1. This is an advance course with objective expose students to the advanced topics of Genetic Engineering

Course Outcomes

Sr. No.	Course outcomes	Level Attainment
CO I	Students will acquire knowledge about the gene cloning and expressi tools developed for bacterial host other than *E.coli*	Familiarity
CO II	Students will have understanding about gene cloning and expression fungal hosts	Familiarity
CO III	Students will acquire advance knowledge about genetic engineering of animals and plants	Assessment
CO IV	Understanding of other gene manipulation methods such as site direc mutations, use of molecular markers, gene knock down knock in etc	Assessment
CO V	Students will be able to comprehend the recent development in the a of genome editing tools and their application	Usage

Topic Covered

S. No.	Contents	Contact Hrs.
1	Cloning in bacteria other than *Escherichia coli* *Cloning Vectors* and Cloning in Gram-negative bacteria other than E. coli, *Cloning Vectors and* Cloning in Gram-positive bacteria	7
2	Cloning in *Saccharomyces cerevisiae* and other fungi Importance, Yeast and fungi transformation, Different kinds vectors of *S. Cerevisiae*, *Cloning and manipulating large fragments of DNA* Yeast promoters, Hetrologus protein expression in yeast and Phichia,	7
3	Gene transfer to animal cells Chemical transfection techniques for animal cells, Physical transfection techniques, selectable marker for animal cells, Plasmid, Viral vectors for the transfection of animal cells	8
4	Genetic manipulation of animals Development of transgenic mice, Applications of genetically modified mice, Nuclear transfer technology to clone animals, Gene transfer to Xenopus oocytes or germline, Gene transfer to fish and drosophila,	6
5	Gene manipulation by Site-directed mutagenesis Introduction, Methods of introduces changes in target genes. (Primers extension and PCR as method for site-directed mutation), *Protein engineering;* Methods for amino acid substitutions at a selected site	4
6	Genomic approaches of gene manipulation Molecular markers, Marker assisted selection, Gene expression studies	4
7	Gene and Genome manipulation by silencing recombination and editing RNAi mechanism and delivery and applications, Recombinase based gene knock out and gene knock in, Gene editing tools and their delivery, Advancement in	6

	genome editing tool, Application of genome editing	
	Total Contact Hours	42

TEXT BOOKS

1. Principles of Gene Manipulation and Genomics SEVENTH EDITION S.B. Primrose and R.M. Twyman Genetic Engineering; Samita Rastogi and Neelam Pathak
2. Recombinant DNA: A Short Course by JD Watson, J. Tooze and DT Kurtz.
3. Research and Review Articles:

Evaluation Scheme:

Assessment	Max. marks	Duration	Course Covered
T1 Test	15	1 hr.	Syllabus covered upto T-1
T2 Test	25	1.5 hrs.	Syllabus covered upto T-2
End Term Test	35	2 hrs.	Entire Syllabus
Teacher Assessment	25	Entire Sem	Based on Assignments, quizzes etc.

Advanced Highway Material and Construction

COURSE CODE:18B1WCE832

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

1. To understand the scope, application potential, evaluation, and performance expectation of the new highway materials.
2. To get familiar with the innovative application concepts of the conventional or the modern materials.
3. Usage of modern materials in highway construction and their innovative application
4. Introduction to new technology used in highway construction

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Students will come to know about the scope, application potential, evaluation, and performance expectation of the new highway materials	Familiarity
CO-2	The students will gain an appreciation for the innovative application concepts of the conventional or the modern materials	Assessment
CO-3	Students will analyze how to use and the benefits of modern materials in highway construction	Assessment
CO-4	Students will become familiar with the new technology used in highway construction	Assessment

Course Contents:

Unit	Contents	Lectures required
1	**Aggregates:** Classification, physical and strength characteristics, Proportioning of aggregates, Aggregate texture and skid resistance, polishing of aggregates.	6
2	**Soil:** Classification, Structural and Constructional problems in soil subgrade, Identification and strength tests, Soil-moisture movement, Sub-soil drainage, Soil stabilization	8
3	**Bitumen:** Bitumen sources and manufacturing, Bitumen constituents, structure and Rheology, Mechanical and engineering properties of	6

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	bitumen, Tests on bitumen, Emulsions – Properties, types, modifications, Durability of bitumen, Adhesion of bitumen, Modified bitumen.	
4	**Mixes**: Desirable properties of mixes, Design of bituminous mixes, Tests on bituminous mixes, Fillers, Theory of fillers and specifications	**6**
5	**Cement Concrete**: Constituents and their requirements, Physical, plastic and structural properties of concrete, Factors influencing mix design, Design of concrete mixes	**8**
6	**Road Construction:** Bituminous road construction procedures and specifications, Quality control requirements. Concrete Road construction: Construction methods, Quality control requirements, Joints in cement concrete pavements, reinforced cement concrete road construction.	**8**
Total Lecture		**42**

Suggested Text Book(s):

1 Krebs, Robert D. And Walker, R. D., ―Highway Materials‖, McGraw Hill Book Co., New York, 1971.

2 Her Majesty‘s Stationery Office, ―Soil Mechanics for Road Engineers‖, Ministry of Transport, Road Research Laboratory, UK, 1966.

3 Her Majesty‘s Stationery Office, ―Bituminous Materials in Road Construction‖, Ministry of Transport, Road Research Laboratory, UK, 1966.

4 Her Majesty‘s Stationery Office, ―Concrete Roads Design and Construction‖, Ministry of Transport, Road Research Laboratory, UK, 1966.

5 Read, J. And Whiteoak, D., ―The Shell Bitumen Handbook‖, Fifth edition, Shell Bitumen, Thomas Telford Publishing, London, 2003.

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes(2)-10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course Outcomes (Advanced Highway Material and Construction)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	3	2	2	2	2	1	2	2	3	3	2	**2.17**
CO-2	3	3	3	2	3	3	1	3	2	3	2	2	**2.5**
CO-3	2	2	2	2	3	2	1	2	2	2	2	2	**2**
CO-4	3	3	3	3	2	2	1	2	2	2	3	2	**2.33**
Average	**2.5**	**2.75**	**2.5**	**2.25**	**2.5**	**2.25**	**1**	**2.25**	**2**	**2.5**	**2.5**	**2**	

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Analog Integrated Circuits

COURSE CODE: 18B11EC411

COURSE CREDITS: 3

CORE/ELECTIVE: CORE

: 3-0-0

Pre-requisite: Basic Electronics and Electrical circuit Analysis

Course Objectives:

1. To provide the student with an understanding of the fundamental characteristics, operations, stabilization, and feedback techniques of operational amplifiers.
2. To make the students acquainted with the applications of special ICs like timers, PLL circuits, regulator circuits, ADCs.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Infer the DC and AC characteristics of operational amplifiers and its effect on output and their compensation techniques.	Familiarity
CO-2	Elucidate and design the linear and non-linear applications of an opamp and special application ICs.	Usage
CO-3	Explain and compare the working of multivibrators using special application IC 555 and general purpose opamp.	Usage
CO-4	Develop skills to design simple filter circuits and various amplifiers and can solve problems related to it.	Assessment
CO-5	Illustrate the function of application specific ICs such as Voltage regulators, PLL and its application in communication.	Assessment

Course Contents:

Unit	Contents	Lectures required
1.	Introduction to Operational Amplifiers: Differential amplifier: Basic structure and principle of operation, calculation of differential gain, common mode gain, CMRR, General operational amplifier stages and internal circuit diagrams of IC 741, Op- Amp basics, Ideal properties, Op-Amp specifications, DC and AC performance characteristics, slew rate, Open and closed loop configurations, Parameters of OP- Amps.	9
2.	Feedback topologies & Oscillators: Negative feedback in amplifier: Voltage-Series, Voltage-Shunt feedback, Current-Series, Current- Shunt feedback, Effect of feedback on gain, bandwidth etc., Calculation of stability, gain margin and phase margin. Positive Feedback in oscillators: Review of the basic concept, Barkhousen criteria for oscillators. Design of oscillator circuits: Clapp, Colpitt, Hartley, Wein Bridge and RC phase shift Oscillator.	9
3.	OP-AMP applications: Inverting & Non-inverting configuration, DC & AC amplifiers, Peaking Amplifier, Summing, Scaling and Averaging Amplifiers, Voltage to current and current to voltage converter, Op- amp as integrator and differentiator, Precision diode, Logarithmic and Anti-logarithmic Amplifier, Zero crossing detector, A/D and D/A Converters.	8
4.	Active Filter & Wave shaping circuits: First order and second order filter design: Low pass, High pass, Band pass, Band Reject & All pass, Universal active filter, Multi-vibrators (Astable, Mono-stable, Bi- stable), Schmitt Trigger, Sample and Hold Circuit, Clippers and Clampers, Comparator.	8
5.	Waveform generators and special function ICs: Square wave generator, Triangular wave generator, Saw-tooth wave generator, Timer IC 555, Voltage-Controlled Oscillator (VCO), Phase-Locked Loop (PLL).	8

Total lectures	4 2

Suggested Text Book(s):

1. R. Gayakwad, "Op-amps and Linear Integrated Circuits", 4th ed., Prentice Hall of India.
2. D. Roy Choudhary S. Jain, "Linear Integrated Circuits", 4th ed., New Age International (P) limited.

Suggested Reference Book(s):

1. William D. Stanley, "Operational amplifiers and Linear Integrated Circuits", 4th ed, Pearson.
2. Sergio Franco, "Design With Operational Amplifiers and Analog Integrated Circuits", 3rd ed., Mcgraw Higher Education.
3. Johan H. Huijsing, Operational Amplifiers – Theory and Design, 3rd edition, Springer.

Other useful resource(s):

1. Link to NPTEL course contents: https://nptel.ac.in/courses/117103063
2. Link to topics related to course:
   - https://nptel.ac.in/courses/122104013/11
   - https://nptel.ac.in/courses/108101091
   - https://nptel.ac.in/courses/117103063/17

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Analog Integrated Circuits)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	1.75
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	2
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	1.75
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	2.08
CO-5	2	3	3	3	3	1	1	1	2	2	1	2	2
Average	2	2.6	2.6	2.6	2.8	1	1	1	2	2.2	1.4	2	

Analog Integrated Circuits Lab

COURSE CODE: 18B17EC471

COURSE CREDITS: 1

CORE/ELECTIVE: CORE

: 0-0-2

Pre-requisite: Basic Electronics lab, Electrical Circuit Analysis Lab

Course Objectives:

1. To provide students a thorough understanding of the analog circuits using different ICs.
2. To learn generation of different kind of waveforms using opamps.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Understand basics of different electronics circuits using op amps.	Familiarity
CO-2	Learn how to generate different frequencies using various oscillators.	Familiarity
CO-3	Design different types of filters.	Usage
CO-4	Design Schmitt Trigger using op amp.	Usage
CO-5	Learn the generation of different waveforms using op amp.	Assessment
CO-6	Study the working of op amp as multivibrator.	Assessment

List of Experiments

S. No.	Description	Hours
1	To become familiar with the use and characteristics of a 741 Op-Amp, in an ideal amplifier configuration as an; inverting amplifier, noninverting amplifier, and voltage follower.	2
2	Simulate and design Adder and Subtractor circuits using Op-Amp.	2
3	Simulate and design Integrator and Differentiator using operational amplifier and characterize their performance in various regions of operation.	2
4	Design and verify the characteristics of RC pahse shift oscillator for required frequency	2
5	Design and verify the characteristics of Wein Bridge oscillator for required frequency	2
6	Simulate and design 1st order HPF and LPF filters and plot their Frequency responses, respectively.	2
7	Simulate and design a Schmitt trigger, using a standard IC741 Op-Amp, to produce a custom voltage transfer characteristic.	2
8	Simulate and design triangular/square waveform generator using IC741	2
9	Simulate and design a monostable multivibrator for required pulse width using IC555 Timer	2
10	Simulate and design astable multivibrator for required frequency and duty cycle using IC555 Timer	2
11	Simulate and design and A-D converter using OPAMP 741	2
12	Simulate and design and D-A converter using OPAMP 741	2
	Total Lab hours	24

Suggested/Resources:

1. R L Boylestad and Nachelsky: Electronic Devices & circuit Theory, 10th Ed.Pearson.
2. Adel S. Sedra, Kenneth C. Smith : Microelectronics Circuits, 5th Ed., Oxford University Press, 2004
3. Link to NPTEL course contents:
   - https://nptel.ac.in/courses/11710306
   - https://nptel.ac.in/courses/117103063 /1
   - https://nptel.ac.in/courses/117103063 /7
   - https://nptel.ac.in/courses/117103063/17

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Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Attendance	15 Marks
4	Lab Assessment	45 Marks
	Total	100 marks

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Average
CO1	3	3	3	3	2	2	1	1	1	1	1	1	1.83
CO2	3	3	3	3	3	1	1	1	1	1	1	3	2.00
CO3	3	3	2	3	2	3	2	1	1	1	2	1	2.00
CO4	3	3	3	2	3	2	1	1	1	1	1	1	1.83
CO5	2	2	3	3	3	3	1	1	1	1	1	1	1.83
CO6	2	3	3	3	2	2	2	2	2	2	2	2	2.25
Average	2.67	2.83	2.80	2.80	2.60	2.20	1.20	1.00	1.00	1.00	1.20	1.40	

Artificial Intelligence Techniques

COURSE CODE: 18B1WEC838

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Prerequisites are good programming skills, basic data structures and algorithms, and some university level mathematics.

Course Objectives:

1. Learn to create expert systems which exhibit intelligent behavior.
2. Learn to create expert systems which exhibit the capability to learn, demonstrate, explain and advice its users.
3. Learn to help machines finding solutions to the complex problems.
4. Learn to design human like machines in a computer friendly manner.
5. To study State of the Art algorithms with engineering applications.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Analyze the need and foundation of Artificial Intelligence	Familiarity
CO-2	Study the Intelligent agents that receive percepts from the environment and perform actions	Assessment
CO-3	Analysis of problem solving, knowledge and reasoning	Assessment
CO-4	Study of application domains.	Usage

Course Contents:

Unit	Contents	Lectures required
1	Introduction to Artificial Intelligence (AI): The History and foundations of AI, Philosophy of AI, Intelligent Agents and Knowledge based Systems, AI Problem Solving, AI Learning and AI Perception, Real World AI.	8
2	Intelligent Agents: Agents and Environments, The concept of Rationality, Performance Measures, The structure of Agents, Agent Programs, Simple reflex Agents, Model based reflex Agents, Goal based Agents, Utility based Agents, Learning Agents.	8
3	Problem Solving: Problem solving Agents, Formulating Problems, Searching for Solutions, Uninformed Search Strategies, Breadth first search, Depth first search, Depth limited Search, Bidirectional search, Informed Search Exploration, Constraint Satisfaction Problems.	7
4	Knowledge and Reasoning: Knowledge based agents, Reasoning Patterns in Propositional Logic, Forward and Backward Chaining, Back tracking Algorithm, First Order Logic, Knowledge Representation, Uncertain Knowledge and Reasoning	7
5	Learning, Perception and Action: Learning from Observations, Forms of Learning, Inductive Learning, Learning Decision Trees, Ensemble Learning, Knowledge in Learning, Statistical Learning, Reinforcement Learning, Perceptional Analysis, Communication as Action	6
6	Applications of AI Techniques: Semantic Interpretation, Probabilistic Language Processing, Robotic Hardware and Software Architectures, Probabilistic Inference, Planning and Search, Localization, Tracking and Control.	6
Total lectures		42

Suggested Text Book(s):

1. Stuart J. Russel and Peter Norvig: Artificial Intelligence: A Modern Approach, Third Edition, Pearson Education Limited, 2014.
2. E. Rich and K. Knight: Artificial Intelligence and Applications, Third Edition, Tata McGraw Hill, 2012.

Suggested Reference Book(s):

1. P. Kulkarni and P. Joshi: Artificial Intelligence, Second Edition, PHI Learning Private Limited, 2015.
2. P. H. Winston: Artificial Intelligence and Applications, Third Edition, PHI Learning Private Limited, 2017.

Other useful resource(s):

Link to topics related to course:

https://nptel.ac.in/courses/106105077/
https://nptel.ac.in/courses/106105079/
https://www.tutorialspoint.com/artificial_intelligence/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Artificial Intelligence Techniques)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	3	3	2	1	1	1	2	2	2	2	1.91
CO-2	3	3	3	3	3	2	1	1	3	2	1	3	2.33
CO-3	2	3	2	2	2	2	2	2	2	2	1	2	2.00
CO-4	3	3	3	3	2	1	1	1	2	3	2	3	2.25
Average	2.50	2.75	2.75	2.75	2.25	1.50	1.25	1.25	2.25	2.25	1.50	2.50	

Advanced Java

COURSE CODE:18B11CI511

COURSE CREDITS: 3

CORE/ELECTIVE: CORE

L-T-P: 3-0-0

Pre-requisite: Object-Oriented Systems and Programming

Course Objectives:

1. Design and develop GUI applications using Abstract Windowing Toolkit (AWT), Swing and Event Handling.
2. Design and develop dynamic web applications using Servlets and JSP.
3. Designing client-server networking applications.
4. Designing distributed applications using RMI.
5. Designing Enterprise based applications by encapsulating an application's business logic.
6. Designing applications using pre-built frameworks.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	To learn and design a full set of Event driven UI widgets and other components, including windows, menus, buttons, checkboxes, text fields, scrollbars and scrolling lists, using Abstract Windowing Toolkit (AWT) & Swings	Usage
CO-2	To learn Java Data Base Connectivity (JDBC) so as to retrieve and manipulate the information on any relational database through Java programs.	Usage
CO-3	To learn the server side programming using Servlets and JSP.	Usage
CO-4	To learn client-server networking programming.	Usage
CO-5	To learn the invocation of the remote methods in an application using RMI	Usage
CO-6	To learn the development of Enterprise based applications, using EJB: Stateful, Stateless and Entity Beans, Using Struts and Hibernate Frameworks.	Usage

Course Contents:

Unit	Contents	Lectures required
1	GUI Programming Designing Graphical User Interfaces in Java, Components and Containers, Basics of Components, Using Containers, Layout Managers, AWT Components, Adding a Menu to Window, Extending GUI Features Using Swing Components, Java Utilities (java.util Package) The Collection Framework : Collections of Objects , Collection Types, Sets , Sequence, Map, Understanding Hashing, Use of ArrayList& Vector. Event Handling Event-Driven Programming in Java, Event- Handling Process, EventHandling Mechanism, The Delegation Model of Event Handling, Event Classes, Event Sources, Event Listeners, Adapter Classes as Helper Classes in Event Handling.	**6**
2	**Java Database Connectivity (JDBC):** JDBC Product, Types of Drivers, Two-Tier Client/Server Model, Three-Tier Client/Server Model, Basic Steps of JDBC, Creating and Executing SQL Statement, The Result Set Object, Working with Database MetaData Interface.	**5**
3	Networking Basics, Client-Server Architecture, Socket Overview, Networking Classes and Interfaces, Network Protocols Network Programming in Java Using the java.net Package, Establishing the two-way Communication between Server and Client, Retrieving a file at server, Learning the DatagramSocket and DatagramPacket Classes, Understanding the Content and Protocol Handlers	**6**
4	Web Application Basics, Architecture and challenges of Web Application, Introduction to servlet, Servlet life cycle, Developing and Deploying Servlets, Exploring Deployment Descriptor (web.xml), Handling Request and Response, Initializing a Servlet, Accessing Database, Servlet Chaining, Session Tracking & Management, Dealing with cookies, Transferring Request, Accessing Web Context, Passing INIT and CONTEXT Parameter, Sharing information using scope object, Controlling concurrent access, User Authentication, Filtering Request and Response, Programming Filter, Filter Mapping, Servlet Listeners. Java Server Pages: Basic JSP Architecture, Life Cycle of JSP (Translation, compilation), JSP Tags and Expressions, Role of JSP in MVC-2, JSP with Database, JSP Implicit Objects, Tag Libraries, JSP Expression Language (EL), Using Custom Tag, JSP Capabilities, Exception Handling, Session Management, Directives, JSP with Java Bean	**10**
5	RMI, Naming Service, Serialization, and Internationalization, RMI Architecture, RMI Registry, Dynamic Code Loading in RMI, RMI API, Creating a Distributed Application using RMI, Naming Services, Directory and Naming Services, Overview of JNDI, Object Serialization, Internationalization, Java and Internationalization, Internationalizing Web Applications	**6**

6	**Enterprise Java Beans (EJB):** Types of EnterpriseJava beans, Session Bean & Entity Bean, Features of Session Bean, Life-cycle of StatefulSeession Bean, Features of Entity Bean, Life-cycle of Entity Bean, Container-managed Transactions & Bean-managed Transactions, Implementing a container-managed Entity Bean Struts: Introduction to the Apache Struts, MVC Architecture, Struts Architecture, How Struts Works? Introduction to the Struts Controller, Introduction to the Struts Action Class, Using Struts ActionFrom Class, Using Struts HTML Tags, Introduction to Struts Validator Framework, Client Side Address Validation in Struts, Custom Validators example, Developing Application with Struts Tiles. Hibernate: Introduction to Hibernate 3.0, Hibernate Architecture, First Hibernate Application.	**9**
Total lectures		**42**

Suggested Text Book(s):

1. Java the Complete Reference, ninth edition by Herbert Schild, Publisher: McGraw Hills
2. Advanced Java Programming by Uttam K. Roy, Publisher: Oxford University Press

Suggested Reference Book(s):

1. Head First EJB 3.0 by Kathy Sierra, Bert Bates, Publisher: O'Reilly Media
2. Head First Servlets and JSP by Bryan Basham, Kathy Sierra & Bert Bates, Publisher: O'Reilly Media
3. Just Hibernate, A Lightweight Introduction to the Hibernate Framework by MadhusudhanKonda, Publisher: O'Reilly Media
4. Programming Jakarta Struts, 2nd Edition by Chuck Cavaness, Publisher: O'Reilly Media

Other useful resource(s):

1. Link to NPTEL course contents:
2. http://www.nptelvideos.com/java/java_video_lectures_tutorials.php
3. https://nptel.ac.in/courses/106105084/28

EvaluationScheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes(2) -10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Java Programming)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	2	2	1	2	2	3	1	3	2	3	**2.3**
CO-2	3	3	2	2	1	2	1	3	2	2	3	3	**2.3**
CO-3	3	3	2	3	3	3	1	3	2	3	3	2	**2.6**
CO-4	3	3	2	3	3	3	1	3	2	3	3	2	**2.6**
CO-5	3	1	1	2	2	3	1	2	1	3	2	3	**2**
CO-6	3	2	3	2	1	3	3	2	2	3	3	3	**2.5**
Average	**3**	**2.5**	**2**	**2.3**	**1.8**	**2.7**	**1.5**	**2.7**	**1.7**	**2.8**	**2.7**	**2.7**	

Advanced Java Lab

COURSE CODE: 18B17CI571

COURSE CREDITS: 1

CORE/ELECTIVE: CORE

L-T-P: 0-0-2

Pre-requisite: None

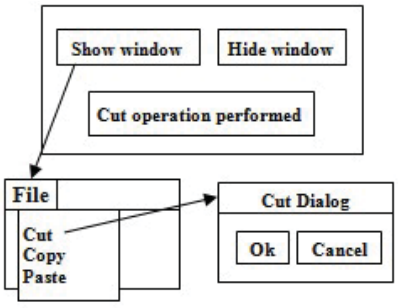
Course Objectives:

1. Design and develop GUI applications using Abstract Windowing Toolkit (AWT), Swing and Event Handling.
2. Design and develop dynamic web applications using Servlets and JSP.
3. Designing client-server networking applications.
4. Designing distributed applications using RMI.
5. Designing Enterprise based applications by encapsulating an application's business logic.
6. Designing applications using pre-built frameworks.

Course Outcomes:

S.No.	Course outcomes	Level of Attainment
CO-1	To learn and design a full set of Event driven UI widgets and other components, including windows, menus, buttons, checkboxes, text fields, scrollbars and scrolling lists, using Abstract Windowing Toolkit (AWT) & Swings	Usage
CO-2	To learn Java Data Base Connectivity (JDBC) so as to retrieve and manipulate the information on any relational database through Java programs.	Usage
CO-3	To learn the server side programming using Servlets and JSP.	Usage
CO-4	To learn client-server networking programming.	Usage
CO-5	To learn the invocation of the remote methods in an application using RMI	Usage
CO-6	To learn the development of Enterprise based applications, using EJB: Stateful, Stateless and Entity Beans, Using Struts and Hibernate Frameworks.	Usage

List of Experiments

S.No.	Description	Hours
1	Design a GUI to create a tabbed pane with two tabs as: Cities and Flavors. The Cities tab consists of four push buttons labeled as "New York", "London", "New Delhi", and "Tokyo". The Flavors tab contains a combo box with three items as "Vanilla", "Chocolate", and "Strawberry".	2
2	Design a GUI using awt/swing components as shown in Fig. 1. The applet window consists of two push buttons (labeled as "Show window" and "Hide window") and a text field. After clicking on the "Show window" button, a window should appear with a menu labeled as File. The File menu consists of three menu items: Cut, Copy, and Paste. After clicking on any of the menu items, a dialog box appears with two push buttons: "Ok" and "Cancel". If "Ok" button is pressed, a message "Cut operation performed" (assuming that the menu item Cut was selected) is displayed on the text field of the applet window. Conversely, if "Cancel" button is pressed, a message "Cut operation cancelled" is displayed on the text field. The dialog box disappears after clicking on the Ok or Cancel button. Similarly, the window disappears after clicking on to the "Hide window" button  Fig. 1. Window and dialog box	2
3	Design a GUI to create a tabbed pane with two tabs: Table and Tree. The first tab contains a table displaying the information of Employee {empid, ename, age}. The second tab contains a tree structure. Insert both JTable and JTree in JScrollPane. JScrollPane has to be inserted at the centre of the BorderLayout manager (with panels). When user clicks on any node of the tree, its path should be displayed on the TextField.	2
4	Consider a table Bank {account_no, customer_name, balance, phone_no, and address}. Write a database application which allows insertion, updation and deletion of records in the Bank table. Print values of all customers whose balance is less than 5,000.	2
5	Write a servlet program to display the current date and time.	2
6	User enters the name and password through an HTML form. Both these parameters are being passed to the Servlet1. The Servlet1 after retrieving the parameters generates a Cookie with username being stored in the cookie. The Servlet1 generates an HTML form, which is linked to the Servlet2. Along with the response object, the Cookie is stored permanently on the client's hard disk. The same user then submits the form to invoke the Servlet2. The Servlet2 must have the provision to access and display the cookie name.	2
7	Write a Servlet to validate the username and password entered by the user. If the username and password are 'abc' and 'def' respectively, the	2

	Sevlet should forward the request to WelcomeServlet; otherwise, it should display an error message: "Incorrect username or password!"	
8	Write a Servlet that connects to the database (MySql) and creates a table emp with the following schema: emp{empid char(5) Primary Key, ename varchar2 not null , age number(2) not null, salary number(7, 2) , address varchar2};	**2**
9	Write a JSP program to display your brief profile including your image, date of birth, address, and educational qualification. Do proper formatting and coloring of this web page.	**2**
10	Write an online phone directory based application using JSP and JDBC. Use the following table to store the phone details: Directory{phone_no, first_name, last_name, address}. The application should have the search facility on all the fields.	**2**
11	Write a JSP program using Java Bean to register users into a web-site. The registration details of users are kept in USER table with attributes as userid varchar2(10), username varchar2(15), and email_id varchar2(15).	**2**
12	Write an enterprise-based application to find the sum of first n numbers. A positive integer number is passed through an HTML form to invoke a servlet called SumSurvlet. SumServlet calls the method int sum(int) that has been defined inside a stateless session bean SumBean. Assume that the web container and the EJB container are available on the same server.	**2**
13	Design a stateful session bean that provides a calculator services. The calculator has the functionality to perform addition, subtraction, multiplication, and division of two real numbers. It can also detect the zero divisors in division operation. Use namespace in this component.	**2**
14	Design an on-line auction business application using entity beans and session beans and other Java Web components. The business includes all routine auction activities such as bidding price, starting price, current highest bid price, time period control, winner notification, and so on.	**2**
Total lab hours		**28**

Suggested Books/Resources:

1. Head First EJB 3.0 by Kathy Sierra, Bert Bates, Publisher: O'Reilly Media
2. Head First Servlets and JSP by Bryan Basham, Kathy Sierra & Bert Bates, Publisher: O'Reilly Media
3. Just Hibernate, A Lightweight Introduction to the Hibernate Framework by Madhusudhan Konda, Publisher: O'Reilly Media
4. Programming Jakarta Struts, 2nd Edition by Chuck Cavaness, Publisher: O'Reilly Media

EvaluationScheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Attendance	15 Marks
4	Lab Assessment	45 Marks
	Total	100 marks

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Average
CO-1	3	3	2	2	1	2	2	3	1	3	2	3	**2.3**
CO-2	3	3	2	2	1	2	1	3	2	2	3	3	**2.3**
CO-3	3	3	2	3	3	3	1	3	2	3	3	2	**2.6**
CO-4	3	3	2	3	3	3	1	3	2	3	3	2	**2.6**
CO-5	3	1	1	2	2	3	1	2	1	3	2	3	**2**
CO-6	3	2	3	2	1	3	3	2	2	3	3	3	**2.5**
Average	**3**	**2.5**	**2**	**2.3**	**1.8**	**2.7**	**1.5**	**2.7**	**1.7**	**2.8**	**2.7**	**2.7**	

Applied Materials Science

COURSE CODE: 18B1WPH532

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE (CSE, IT)

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

1. To enable the students to get better understanding about materials, properties and their applications in engineering
2. To familiarize students for making proper selection of materials for different applications..
3. To enable the students to use the knowledge about materials for their projects and ultimately apply the materials knowledge in their respective professional career.
4. At the conclusion of the course, the student should have a far greater capacity to read and understand technical articles such as those seen in the IEEE Transactions on Electron Devices, IEEE Transactions on Nanotechnology, Computer-aided design, Computational Materials Science *etc*.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	To learn the fundamentals and Science of Materials.	Familiarity
CO-2	To implement the concepts and theories for analyzing the behaviour of the materials.	Familiarity
CO-3	To execute the concepts and theories in solving the problems related to material properties and their applications.	Analytical & Computational skills
CO-4	To introduce innovations in areas like Display Technology and Engineering Materials Science, etc.	Innovative Skills
CO-5	To analyze various materials for scientific and technical applications	Technical skills

Course Contents:

Unit	Contents	Lectures required
1	Dielectrics: Polarization mechanism & Dielectric Constant, Behavior of polarization under impulse and frequency switching, Dielectric loss, Spontaneous polarization, Piezoelectric effect; Applications of Dielectric Materials.	**12**
2	Polymers: Various types of Polymers and their applications; Mechanical behaviour of Polymers, synthesis of polymers. Conducting polymers	**4**
3	Ceramics: Structure, Types, Properties and Applications of Ceramics; Mechanical 2behaviour and Processing of Ceramics	**3**
4	Magnetism: Concept of magnetism, Classification, dia-, para-, ferro-, antiferro- and ferri-magnetic materials, Their properties and Applications; Hysteresis; Applications.	**9**
5	Superconductivity: Meissner effect, Critical field, type-I and type-II superconductors; Field penetration and London equation; High temperature Superconductors and their Applications.	**6**
6	Optical fibres: Light propagation in fibers and Graded Index fibers, Numerical Aperture and Attenuation, Single and Multimode.	**4**
7	New Engineering Materials: Metallic Glasses, Shape Memory Alloys, Memory Effect, Nano-materials- significance of 2anoscale, 0-Dimensional, 1-Dimensional, 2- Dimensional, 3- Dimensional nanostructures, Applications.	**4**
Total lectures		**42**

Suggested Text Book(s):

1. S. O. Pillai, Solid State Physics, New age international publishers, 7th edition (2016)
2. William D. Callister and David G. Rethwisch, Materials science and engineering: an introduction, John Wiley & Sons, 8th edition (2010).
3. M.A. Wahab, Solid State Physics:Structure and Properties of Materials, Narosa, 3rd edition, (2015).

Suggested Reference Book(s):

1. Charles Kittel, Introduction to Solid State Physics. John Wiley & Sons, 8th edition 2005.
2. S. Sharma and J. Sharma, Engineering Physics, Pearson India (2018).

Other useful resource(s):

1. http://www.advancedsciencenews.com/best-of-advanced-optical-materials/
2. https://onlinecourses.nptel.ac.in/noc19_ph04/preview

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes(2) -10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Materials Science)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3										3	3
CO-2	3											3	3
CO-3	1	1	1									1	1
CO-4	2	2	2	2								2	2
CO-5	3	3	3	3					3			3	3
Average Score	2.4	2.25	2	2.5					3			2.4	2.425

Automation and Robotics

COURSE CODE: 20B1WEC731

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Prerequisite: None

Course Objectives:

1. To develop the student's knowledge in various robot structures and their workspace.
2. To use the robotic system for logic building & programming and to solve many engineering problems.

Course Outcomes:

Sl. No.	Course Outcomes	Level of Attainment
1	Learn about brief history, types, requirement and architecture of automation, and their applications	Familiarity
2	Learn about PLC, DCS and SCADA, and their applications	Assessment
2	Learn basic principles of robotics, its configurations, kinematics, dynamics, motion planning and control	Assessment
3	Acquire knowledge about the principles of various sensors, actuators and their applications in robots.	Assessment
4	Understand the concept of dynamics and control for a typical pick and place robot.	Usage

Course Contents:

Unit	Contents	Lectures required
1	Introduction: History of automation, Automation systems, types of automation, Automation overview, Requirement of automation systems, Architecture of Industrial Automation system, Advantages and limitations of Automation, Industrial revolutions.	6
2	Automation components: Sensors and actuators, Electric, Hydraulic, Pneumatic, actuators, process control valves, Introduction of DC and AC servo drives for motion control. Controllers, Transmitters and Signal Conditioning: Need of transmitters, Standardization of signals, Current, Voltage and Pneumatic signal standards, 2-Wire & 3-Wire transmitters, Analog and Digital signal conditioning for sensors, Smart and Intelligent transmitters	8
3	PLC, SCADA & Distributed control system: Elements of SCADA, Features of SCADA, MTU, RTU Functions, Applications of SCADA, Communications in SCADA, Introduction to DCS, Architecture, Input and output modules, Specifications of DCS	6

4	Introduction to Robotics: Definition of robot, types of robots, classification and usage, Terminology of robotics, Specifications of robot, Architecture of robotic systems, Robot Sensors and Machine Vision System: Internal and external sensors: position, velocity and acceleration sensors, proximity sensors, force sensors, laser range finder; Robot vision: image processing fundamentals for robotic applications	8
5	Robot Arm Kinematics and Dynamics:Position and orientation of a rigid body, Homogeneous transformations, Forward kinematics, Inverse kinematics, Lagrange formulation of dynamics	6
6	Motion Planning and Control: Joint and Cartesian space trajectory planning and generation, Classical control concepts using the example of control of a single link and two-link manipulators, Independent joint PD and PID control, Control of a multi-link manipulator	6
Total lectures		42

Suggested Text Book(s):

1. J. J. Craig, “Introduction to Robotics- Mechanics and Control”, Pearson,3rd Edition, 2009.
2. Spong and Vidyasagar, “Robot Dynamics and Control”, Wiley Student Edition, John Wiley and Sons, 2013.
3. Madhuchhanda Mitra, SamarjitSen Gupta, “Programmable Logic controllers and Industrial Automation”, Penram International, 2008
4. C.D. Johnson, “Process Control Instrumentation Technology”, 8th Ed., PHI, 2015

Suggested Reference Book(s):

1. Sciavicco and Siciliano, “Modeling and Control of Robot Manipulators”, Springer, 2nd Edition, 2002.
2. D.K. Pratihar, “Fundamentals of Robotics”, Narosa Publishing House, 1st Edition, 2017.
3. AshitavaGhoshal, “Robotics-Fundamental Concepts and Analysis”, Oxford University Press, 6thImpression, 2010. 8.
4. R. K. Mittal and I. J. Nagrath, “Robotics and Control”, Tata McGraw Hill, New Delhi, 4th Reprint, 2005.
5. Gregory K. McMillan, P. Hunter Vegas, “Process / Industrial Instruments and Controls Handbook,” 6th Ed., McGraw Hill, 2019
6. Bela G. Liptak, KrisztaVenczel, “Instrument and Automation Engineers' Handbook: Process Measurement and Analysis,” 5th Ed., CRC Press, 2016

Other useful resource(s):

1. Link to NPTEL course contents:https://nptel.ac.in/courses/112101099/
2. Other links to course material: https://nptel.ac.in/downloads/112101098/
3. Material provided by IIT Bombay under eLSI project: http://elsi.e-yantra.org/resources

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered up to T-1
2	T-2	25	1.5 Hours	Syllabus covered up to T-2
3	T-3	35	2 Hours	Entire Syllabus

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4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Automation and Robotics)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	2	2	1	1	2	2	2	**1.8**
CO-2	3	3	3	2	3	2	2	1	1	2	3	3	**2.3**
CO-3	3	3	3	3	3	3	3	1	2	3	3	3	**2.8**
CO-4	3	3	3	3	3	3	3	1	2	3	3	3	**2.8**
CO-5	3	3	3	3	3	3	3	1	2	3	3	3	**2.8**
Average	**2.8**	**2.8**	**2.8**	**2.6**	**2.8**	**2.6**	**2.6**	**1**	**1.6**	**2.6**	**2.8**	**2.8**	

Advances in Computational System Biology

COURSE CODE

COURSE CREDITS: 3

CORE/ELECTIVE: CORE

L-T-P: 3-0-0

Pre-requisite: Molecular Biology

Objective:

1. To enable students to predict and ultimately control functionalities of complex biological systems

Sr. No.	Course outcomes	Level Attainment
CO I	Students will acquire knowledge on system biology	Familiarity
CO II	Students will have understanding about gene regulatory network	Familiarity
CO III	Students will acquire advance knowledge about metabolic networking	Assessment
CO IV	Understanding on Signal transduction	Usage
CO V	Students will be able to comprehend system biology	Usage

Course Outline

Sr. No.	**Contents**	**Hours Allotted**
1	Introduction to Systems biology and associated entities. System and its properties. Types of biological networks and their characteristics. Comparison of bioinformatics, and other similar streams with systems biology and its progression towards synthetic biology.	5
2	Gene regulatory networks, Genetic Network Analysis and System Discovery. Modeling Complex Biological Systems , Approaches to *Numerical* Simulation of Regulatory Pathways.	5
3	Metabolic Networks and pathways, Mass/Flux Balance Analysis. Characteristics and applications of metabolic pathways. Partial differential equations for the same. Recent research based developments in metabolic networks.	6
4	XML for Bioinformatics and systems biology, includes BioXML, SBML, CellML and their practical applications towards modelling and simulations of biological systems	6
5	Signal Transduction Networks and Pathways, their characteristics and applications. Recent research based developments in TRNs.	6
6	Systems Approach to Metabolic Networks and Protien-Protein Interaction Networks, Online tools and databases for SYSTEMS BIOLOGY- STRING, BIND, MINT, IPATH, GeneGo, Gypasi, MetaCYC	6
7	Biocircuits: Blocks and Designing; Various case studies along with their applications. Petri Nets and modeling. E-Cell and other bio-electronic Projects	4
8	Research based methods for solving biological network problems for all kind of	4

	biological networks.	
	Total	**42**

Text and Reference Books:

1. **Systems Modeling in Cellular Biology.** by Zoltan Szallasi, Joerg Stelling, Vipul Periwal, MIT Press,
2. **Systems Biology : Properties of Reconstructed Networks.** by Bernard Palsson, Cambridge Univ. Press
3. **Advances in Systems Biology (Advances in Experimental Medicine and Biology).** Opresko, L., Gephart, J., and Mann, M. (eds.), Plenum US, 2005
4. **Artificial Intelligence Methods and Tools For Systems Biology.** Dubitzky, W. and Azuaje, F. (eds.), Kluwer Academic Publisher
4. **Metabolome Analyses: Strategies for Systems Biology.** Vaidyanathan, S. et al (eds.), Springer-Verlag
5. **Systems Biology in Practice: Concepts, Implementation And Application.** Klipp, E et al., John Wiley & Sons Inc.
6. **Foundations of Systems Biology.** Kitano, H.(ed.); The MIT Press
7. **Systems Biology.** Alberghina L. & Westerhoff, H.V., eds.; Springer Verlag

Evaluation Scheme:

Assessment	Max. marks	Duration	Course Covered
T1 Test	15	1 hr.	Syllabus covered upto T-1
T2 Test	25	1.5 hrs.	Syllabus covered upto T-2
End Term Test	35	2 hrs.	Entire Syllabus
Teacher Assessment	25	Entire Sem	Based on Assignments, quizzes etc.

Antenna and Wave Propagation

COURSE CODE: 18B1WEC742

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

1. To make students understand the fundamental theory and concepts of antenna and propagation of waves.
2. Make them aware to the radiation characteristics of different types of antennas, their measurement and applications of various antennas.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Comprehend the fundamental theory and concepts of radiation, antenna and significance of antenna parameters.	Familiarity
CO-2	Assess the power and usefulness of UHF, VHF and Microwave Antennas, microstrip patch antennas their requirements, specifications, characteristics and design relations.	Assessment
CO-3	To define and distinguish between different phenomenon of wave propagation (ground wave, space wave and sky wave), their frequency dependence, and estimate their characteristics, identifying their profiles and parameters involved.	Assessment
CO-4	Reveal different applications of the various types of antenna to solve engineering and other problems	Usage

Course Contents:

Unit	Contents	Lectures required
1	ANTENNA FUNDAMENTALS: Introduction, Radiation Mechanism – single wire, 2 wire, dipoles, Current Distribution on a thin wire antenna. Antenna Parameters - Radiation Patterns, Beamwidths, Beam Area, Radiation Intensity, Beam Efficiency, Directivity, Gain and Resolution, Antenna Apertures, Aperture Efficiency Antenna temperature and signal to noise ratio.	7
2	RADIATION OF ELECTRIC DIPOLE: Potential functions and the electromagnetic field, Oscillating electric dipole derivations for E and H field components in spherical coordinate systems, Power Radiated by a current element, Application to antennas, Radiation from quarter wave monopole and half wave dipoles, equality of directional patterns and effective lengths of transmitting and receiving antennas, directional properties of dipole antennas, antenna feeding methods.	8
3	ANTENNAS FOR SPECIAL APPLICATIONS: Broadband antenna, Frequency-independent antenna, log periodic antennas, Antennas design consideration for satellite communication, antenna for terrestrial mobile communication systems, GPR, Embedded antennas, UWB, Plasma	6
4	ANTENNA MEASUREMENTS: Radiation Pattern measurement, Distance requirement for uniform phase, uniform field amplitude requirement, Introduction to phase measurement; Gain Measurement: Comparison method, Near field method, Introduction to current distribution measurement, Measurement of antenna efficiency, measurement of Noise figure and noise temperature of an antenna polarization measurement, Anechoic Chamber measurement.	7

5	WAVE PROPAGATION - I: Concepts of Propagation – frequency ranges and types of propagations. Ground Wave Propagation–Characteristics, Parameters, Wave Tilt, Flat and Spherical Earth Considerations. Sky Wave Propagation – Formation of Ionospheric Layers and their Characteristics, Mechanism of Reflection and Refraction, Critical Frequency, MUF & Skip Distance – Calculations for flat and spherical earth cases, Optimum Frequency, LUHF, Virtual Height, Ionospheric Abnormalities, Ionospheric Absorption.	7
6	WAVE PROPAGATION – II: Fundamental Equation for Free-Space Propagation, Basic Transmission Loss Calculations. Space Wave Propagation – Mechanism, LOS and Radio Horizon. Tropospheric Wave Propagation – Radius of Curvature of path, Effective Earth's Radius, Effect of Earth's Curvature, Field Strength Calculations, M-curves and Duct Propagation, Tropospheric Scattering.	7
Total lectures		42

Suggested Text Book(s):

1. E.C.Jordan and Balmain: Electromagnetic waves and Radiating Systems, 2nd Edition, PHI, 2006
2. Constantine A. Balanis: Antenna Theory Analysis and Desin, John Wiley, 2nd Edition,2007.

Suggested Reference Book(s):

1. John D.Kraus, Ronald J Marhefka and Ahmad S Khan: Antennas for all Applications, Tata McGraw-Hill Book Company, 3rd Edition, 2007.
2. G.S.N.Raju: Antenna Wave Propagation, Pearson Education, 1st Edition,2004.
3. R.E.Collins, "Antenna and Radiowave propagation", 3rd Edition, Mc Graw Hill, 2005.

Other resources/ learning website:

www.nptel.ac.in
www.antenna-theory.com

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Antenna and Wave Propagation)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	2	2	3	2	1	1	1	2	3	3	2.17
CO-2	3	3	3	3	3	2	1	1	1	2	2	3	2.25
CO-3	3	3	3	3	3	2	1	1	1	2	2	3	2.25
CO-4	3	3	3	3	3	3	3	2	3	3	3	3	2.92
Average	3	3	2.75	2.75	3	2.25	1.5	1.25	1.5	2.25	2.5	3	2.40

BIOPROCESS TECHNOLOGY LAB

COURSE CODE: 18MS7BT212
COURSE CREDITS: 1
CORE/ELECTIVE: CORE
L-T-P: 0-0-2

Pre-requisite: Microbiology Lab, Biochemistry Lab

Course Objectives:

1. Provide exposure to the students with hands on experience on various practices in Bioprocess Technology.
2. Enable students to link the theoretical knowledge of bioprocess technology with the experiments.
3. Enable to Learn how to operate bench scale fermenter
4. Learn how to determine various Monod's Kinetics parameter
5. Learn how to recover the various bioproduct after their production
6. Learn how to characterize the products after their recovery

List of Experiments

S. No.	Description	Hours
1	Introduction of Lab and lab safety	**1**
2	Describe the various parts of the bench-top fermenter (bioreactor) along with their functions.	**1**
3	Batch fermentation using shake-flask for ethanol production by *Saccharomyces cerevisae*.	**2**
4	Isolation and screening of microbes of industrial importance	**2**
5	Medium Optimization for enhancing the enzyme production (C- and N-source)	**2**
6	To study growth kinetics parameters of *E. coli*. a) Specific growth rate (μ) h^{-1} b) Maximum specific growth rate (μ_m) h^{-1} c) Saturation constant (K_s) gm/l d) Growth yield coefficient ($Y_{x/s}$) gm cell/gm substrate. e) Productivity of biomass gm cell/litre/h.	**4**
7	Setting up of a fermentation process for the production of extracellular industrial enzyme from the selected microbe of industrial importance	**1**
8	Downstream processing of the industrial enzyme produced by the fermentation process. a) Clarification b) Yield estimation c) Concentration using salt-induced precipitation	**4**

	d) Dialysis e) Purity check through SDS-PAGE and specific activity determination	
9	Disruption of yeast cells using sonication to recover intracellular Invertase enzyme	**2**
10	Determination of protein and enzyme content in the cell lysate after the cell disruption	**2**
11	Preparation of Immobilized yeast cells in calcium alginate beads	**2**
Total Lab hours		**24**

Suggested/Resources:

1. M.L. Shuler and F. Kargi, "Bioprocess Engineering--basic Concepts", 2nd Edn. Prentice-hall Of India Pvt Ltd (2008).
2. Lab Manual
3. Keith Wilson, John Walker, “Principles and Techniques of Biochemistry and Molecular Biology, 7th ed., Cambridge University Press, Singapore, 2010.
4. Raja Ghosh, “Principles of Bioseparation Engineering”, World Scientific Publishing Co. Pte. Ltd., Singapore, 2006.
5. Pauline M. Doran, “Bioprocess Engineering Principles”, 8th ed., Academic press, New York, 2003.
6. Peter F. Stanbury, Stephen J. Hall & A. Whitaker, "Principles of Fermentation Technology", Â Elsevier India Pvt Ltd. (2007).
7. Downstream Processing by Dr. Mukesh Doble, IIT Madras https://nptel.ac.in/courses/102106022/
8. http://iitd.vlab.co.in/?sub=63

Biomedical Signal Processing

COURSE CODE: 18B1WEC741

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

1. To introduce different biomedical signals.
2. To apply different methods to analyze and filter the signals.
3. To detect events in signals used for diagnosis.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Understand the origin of different biomedical signals.	Familiarity
CO-2	Able to filter out the noise and artifacts from the medical signals.	Usage
CO-3	Able to extract different events from the signals.	Usage
CO-4	Understand different waveform analyzing methods for medical signals.	Assessment

Course Contents:

Unit	Contents	Lectures required
1	Introduction to Biomedical Signals:- Action potential of neurons, Electrocardiography, Electroencephalogram, Electromyography, Electroretinogram and Electrooculography.	10
2	Filtering for Removal of artefacts: Types of Noise, Power Line and high frequency noise interference, motion artefacts, Filters for removal of interference, Illustration of the Problem with Case Studies.	8
3	Detection of Events: Illustration of the Problem with Case Studies, Derivative based Approaches for QRS detection; Autocorrelation function and Cross- correlation functions for the detection of events in EEG.	8
4	Waveform Analysis: Morphological Analysis of waves, Envelope detection and Analysis; Analysis of activity using Root Mean Square value, Zero-crossing rate, Turns Count, and Form factor.	8
5	Frequency-domain Analysis: Spectral Analysis of biomedical signals, Estimation of PSD; Measures Derived from PSDs.	8
Total lectures		42

Suggested Text Book(s):

1. R. S Khandpur and Raghbir Khandpur: Biomedical Instrumentation, 2nd Ed., McGraw-Hill Education; , 2003.
2. Rangaraj M. Rangayyan, Biomedical Signal Analysis, 2nd Ed., Wiley,2015.

Suggested Reference Book(s):

1. Leslie Cromwell, Fred Weibell J, Erich Pfeiffer. A: Biomedical Instrumentation and Measurements, Prentice-Hall India, 2nd Edition, 1997.
2. John G. Webster: Medical Instrumentation application and design, John Wiley, 3rd Edition, 1997.

Other useful resource(s):

Link to NPTEL course contents: https://nptel.ac.in/courses/108105101/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes(2) -10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Biomedical Signal Processing)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	1	3	2	3	2	2	3	2	2	1	3	2.28
CO-2	3	3	3	3	3	1	1	2	2	2	1	3	2.25
CO-3	3	3	3	3	3	1	1	2	2	2	1	3	2.25
CO-4	3	3	3	3	3	1	1	2	2	2	1	3	2.25
Average	2.75	2.5	3	2.75	3	1.25	1.25	1.25	2	2	1	3	

C# and VB.NET Lab

COURSE CODE: 18B1WCI677

COURSE CREDITS: 1

CORE/ELECTIVE: ELECTIVE

L-T-P: 0-0-2

Pre-requisite: None

Course Objectives:

1. Knowledge of .NET Framework.
2. Programming in C # and VB.NET in Visual Studio Environment
3. Knowledge of object-oriented programming in the C # and VB.NET languages
4. Programming for windows application development
5. Programming for web application development

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Comprehensive knowledge of .NET Framework, C#.NET and VB.NET.	Assessment
CO-2	Knowledge of C#.NET and VB.NET languages.	Assessment
CO-3	Students will able to develop windows applications using C# and VB.NET.	Assessment
CO-4	Students will able to develop web applications using ASP.NET with C# and VB.NET .	Usage
CO-5	Develop a data driven windows and web application.	Usage

List of Experiments:

Experiment	Details	Lab Hours
Experiment 1	Implementation of Class (class, objects, member variable, properties, member functions, constructors)	**2**
Experiment 2	Implementation of Inheritance (Single , Multilevel,)	**2**
Experiment 3	Implementation of Polymorphism (virtual function, overriding, abstract class)	**2**
Experiment 4	Develop GUI Scientific Calculator.	**2**
Experiment 5	Develop a Mini Word application using menu controls.	**2**
Experiment 6	Develop mini browser application using browser control	**2**
Experiment 7	Create simple web form for registration page using standard web controls	**2**
Experiment 8	Apply validation controls on registration page	**2**
Experiment 9	ASP.NET Page Life Cycle, ASP.NET Page Life Cycle Events	**2**
Experiment 10	Create 5 ASP.NET pages (Home, Department, Library, Downloads, Contact us) and apply navigational controls using site map	**2**
Experiment 11	Create Table in SQL Server for registration page created in experiment 7 and apply database connectivity i.e., on click submit button data should be inserted to Table.	**2**
Experiment 12	Create Login Page with database connectivity	**2**

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Experiment 13	Create asp.net page for listing all the registered users in Grid View	**2**
Experiment 14	Apply functionality of Searching, Creation, Updating and Deletion of registered users.	**2**
TOTAL Lab hours		**28**

Suggested Books/Resources:

1. NET Framework Essentials, 3rd Edition by By Hoang Lam, Thuan Thai Publisher: O'Reilly Media
2. Head First C#, 3rd Edition By Andrew Stellman, Jennifer Greene Publisher: O'Reilly Media
3. ASP.NET 4 Unleashed 1st Edition, by Stephen Walther
4. Pankaj Agrawal – Principal of .Net Framwork
5. Vaya Kogent - .NET Programming Black Book – Wiley
6. VB.NET Black Book by Steven Holzner –Dreamtech
7. VB.NET –Wrox Publication
8. C# programming Black Book by Matt Telles
9. Link to topics related to course:
   - **a.** https://docs.microsoft.com/en-us/dotnet/
   - **b.** https://msdn.microsoft.com/en-us/library/ff361664(v=vs.110).aspx
   - **c.** https://msdn.microsoft.com/en-us/library/aa286485.aspx
   - **d.** https://blogs.msdn.microsoft.com/dotnet/

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Attendance	15 Marks
4	Lab Assessment	45 Marks
	Total	100 marks

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Average
CO-1	3	3	3	3	2	3	3	2	3	2	3	3	**2.8**
CO-2	3	3	3	3	2	3	3	2	3	2	3	3	**2.8**
CO-3	3	3	3	3	2	3	3	2	3	2	3	3	**2.8**
CO-4	3	3	3	3	2	3	3	2	3	2	3	3	**2.8**
CO-5	3	3	3	3	2	3	3	2	3	2	3	3	**2.8**
Average	**3**	**3**	**3**	**3**	**2**	**3**	**3**	**2**	**3**	**2**	**3**	**3**	

Data Structure and Software Design Lab

COURSE CODE: 18B1WCI671

COURSE CREDITS: 1

CORE/ELECTIVE: ELECTIVE

L-T-P: 0-0-2

Pre-requisite: None

Course Objectives:

1. Apply array and stack data structures in mathematical problem solving and implementing various compiler and operating systems mechanisms, respectively.
2. Apply queue and linked list to implement various compiler and operating systems mechanisms.
3. Apply tree and graphs to implement various compiler, computer networks and real time google map applications.
4. Apply priority queue to implement scheduling jobs, sorting huge files and shortest path computation. Apply hashing in implementation of programming languages, file systems, pattern search, and distributed system concepts.
5. Apply data structures in Computer Networks, databases, and image & computer vision.
6. Understanding data structures used in audio/video files, 2D/3D maps, and machine learning & genetics.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	To learn to apply array and stack data structures in mathematical problem solving and implementing various compiler and operating systems mechanisms, respectively.	Assessment
CO-2	To learn to apply queue and linked list to implement various compiler and operating systems mechanisms.	Assessment
CO-3	To learn to apply Apply tree and graphs to implement various compiler, computer networks and real time google map applications.	Assessment
CO-4	To learn to apply priority queue to implement scheduling jobs, sorting huge files and shortest path computation. Apply hashing in implementation of programming languages, file systems, pattern search, and distributed system concepts.	Assessment
CO-5	To learn to apply data structures in Computer Networks, databases, and image & computer vision.	Assessment
CO-6	To learn and understand data structures used in audio/video files, 2D/3D maps, and machine learning & genetics.	Usage

List of Experiments:

S. No.	Description	Hours
1	Using arrays to (a) find maximum, minimum, mean, median, average (b) performing operations – sorting, merging, traversal and retrieval (c) complex mathematical problems and image processing transformations	**3**
2	Using stack to (a) evaluating arithmetic expressions (b) storing function arguments and local data as programs are executed (c) storing local variables used inside a function block in compilers/operating systems	**4**

	(d) undo mechanisms in text editors (e) backtracking in a series of elements (f) parsing computer languages in compilers (g) processing function calls and implementing recursive functions (h) creating space for parameters and local variables in language processing, compiler‟s syntax check for matching braces	
3	Using queue to (a) handle interrupts in operating system (b) store incoming data in application programs (c) process synchronization in operating system (d) CPU job scheduling and disk scheduling	**3**
4	Using linked list to (a) dynamic memory management (b) representing polynomials and performing addition, subtraction, multiplication, etc. with polynomials (c) symbol tables for balancing parenthesis and representing sparse matrix	**3**
5	Using trees to (a) syntax validation in compilers (b) implementing sorted dictionary (c) usage in Internet protocols (d) storing router tables (e) quick traversal and searching of directory structures	**3**
6	Using graphs to (a) representing link structure of a website using directed graph (b) job scheduling problems of CPU (c) simultaneous execution of jobs problem between set of processors and set of jobs (d) real time applications of data structures: determination of cities using google maps to find population, finding addresses on maps	**3**
7	Using priority queue to (a) efficiently schedule jobs (b) sorting huge files (c) efficiently computing shortest paths in graphs (d) Minimum spanning trees greedy algorithms: Kruskal‟s and Prim‟s	**3**
8	Using hashing to (a) implement file systems and pattern search (b) distributed key-value storage and hash functions used in modern distributed systems optimizing storage of services like Dropbox, Google Drive and Yandex Disk!	**2**
9	Implementing data structures for (a) Computer Network protocols and routing tables. (b) Indexes used in databases (c) Image and computer vision	**2**
10	Implementing data structures for (a) Audio and video files (b) 2D/3D maps (c) Learned data structures for Machine Learning algorithms	**2**
Total Lab Hours		**28**

Suggested Books/Resources:

1. Horowitz and Sahani: Fundamental of Data Structures in C, 2nd Edn, 2008
2. Data structures and network algorithms by Robert Endre Tarjan, Society for Industrial and Applied Mathematics (SIAM), ISBN-0-89871-187-8.

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3. Computer Networks, 5th edition, Andrew S. Tanenbaum and David J. Wetherall, Pearson Education.
4. Data structure and operating system (Wiley series in computing) by Teodor Rus, John Wiley & Sons Ltd., ISBN-13: 978-0471995173
5. Compiling Techniques by F.R.A. Hopgood, Macdonalds
6. http://www.chilton-computing.org.uk/acl/literature/books/compilingtechniques/contents.htm
7. Compiler construction by William M. Waite and Gerhard Goos, Springer Verlag, ISBN-0-387-90821-8.
8. Data Structures for Databases by Jaochim Hammer and Markus Schneider, https://www.cise.ufl.edu/~mschneid/Research/papers/HS05BoCh.pdf
9. Genetic Algorithms + Data Structures = Evolution Programs by Zbigniew Michalewicz, Springer, ISBN-3-540-60676-9 and ISBN-3-540-58090-5 (2nd edition).
10. Algorithms for graphics and image processing by Theo Pavlidis, Computer Science Press , Inc. Fundamentals of Database Systems" Elmasri, Navathe, Pearson Education.
11. "Database system concepts" Henry F Korth, Abraham Silberschatz, S. Sudurshan, McGraw-Hill
12. Deo, N., Graph Theory with Applications to Engineering and Computer Science, Prentice-Hall, 1974.
13. Digital Image Processing, R.C. Gonzalez and R.E. Woods, 2nd edition, Pearson Prentice Hall, 2008
14. Operating System Concepts by Silberschatz and Galvin, 9th Edition, John Wiley & Sons.
15. Data structure for 2D/3D maps: http://www.geog.ucsb.edu/~kclarke/AACC/Chapter08.pdf
16. Audio Formats : https://www.makeuseof.com/tag/audio-file-format-right-needs/Video Formats :
17. https://www.lcps.org/cms/lib/VA01000195/Centricity/Domain/1349/Resources/Video_file_formats.pdf

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Attendance	15 Marks
4	Lab Assessment	45 Marks
	Total	100 marks

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Average
CO-1	3	3	3	3	2	3	3	2	3	2	3	3	**2.8**
CO-2	3	3	3	3	2	3	3	2	3	2	3	3	**2.8**
CO-3	3	3	3	3	2	3	3	2	3	2	3	3	**2.8**
CO-4	3	3	3	3	2	3	3	2	3	2	3	3	**2.8**
CO-5	3	3	3	3	2	3	3	2	3	2	3	3	**2.8**
CO-6	3	2	2	3	3	3	3	2	3	2	3	3	**2.7**
Average	**3**	**2.8**	**2.8**	**3**	**2.2**	**3**	**3**	**2**	**3**	**2**	**3**	**3**	

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C# and VB.NET

COURSE CODE: 18B1WCI637

COURSE CREDITS: 2

CORE/ELECTIVE: ELECTIVE

L-T-P: 2-0-0

Pre-requisites: C/C++ and OOPs

Course Objectives:

1. Knowledge of .NET Framework.
2. Programming in C # and VB.NET in Visual Studio Environment
3. Knowledge of object-oriented programming in the C # and VB.NET languages
4. Programming for windows application development
5. Programming for web application development

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Comprehensive knowledge of .NET Framework, C#.NET and VB.NET	Familiarity
CO-2	Knowledge of C#.NET and VB.NET languages.	Assessment
CO-3	Students will able to develop windows applications using C# and VB.NET	Assessment
CO-4	Students will able to develop web applications using ASP.NET with C# and VB.NET	Assessment
CO-5	Develop a data driven windows and web application	Usage

Course Contents:

Unit	Contents	Lectures Required
1	**.NET Framework**: Introduction to C#.NET, VB.NET and VS.NET, Features of C#.NET,VB.NET and VS.NET, The Common Language Runtime (CLR), Memory Management, Cross Language Integration, metadata and the IL Disassembler. C# and VB.NET basics ,Class, Objects, Inheritance, Polymorphism, Error Handling, Common Type System (CTS), .NET Framework Class Library (FCL), Microsoft Intermediate Language(MSIL), Just In Time(JIT) Compiler, Garbage Collection	7
2	**Windows Programming:** Intro to C# and VB.NET GUI dev in Visual Studio, Windows Forms and built in controls, Delegates and Events, Common Controls, Button, CheckBox, Label, Dialog boxes, TreeView and ListView, Custom Controls etc.	7
3	**ASP.NET using C# and VB.NET**: Introduction of ASP.NET using C# and VB.NET, Concept of Web Applications, ASP.NET Architecture, Page Composition Parts ASP.NET, Page Life Cycle, Page Life Cycle Events, ASP.NET Server Controls, HTML Server Controls, Web Server Controls, List Controls, Validation Controls, User Controls & their uses, Navigation Controls, Login Controls, Custom Controls	11
4	**ADO.NET:** Introduction of SQL, Components of SQL, Basic SQL Commands, Data Binding in ASP.Net, Data Binding Expressions, Data Sources & Controls, Insert, Update, Delete Operations using Data Source Controls, Working with Grid View Control Data bound controls DetailsView control **Security and Deployment:** Security in the .NET framework and Deployment in the .NET	7

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Total lectures	32

Suggested Text Book(s):

1. .NET Framework Essentials, 3rd Edition by By Hoang Lam, Thuan Thai Publisher: O'Reilly Media
2. Head First C#, 3rd Edition By Andrew Stellman, Jennifer Greene Publisher: O'Reilly Media
3. ASP.NET 4 Unleashed 1st Edition, by Stephen Walther

Suggested Reference Book(s):

1. Pankaj Agrawal – Principal of .Net Framwork
2. Vaya Kogent - .NET Programming Black Book – Wiley
3. VB.NET Black Book by Steven Holzner –Dreamtech
4. VB.NET –Wrox Publication
5. C# programming Black Book by Matt Telles

Other useful resource(s):

1. Link to topics related to course:
   - **i.** https://docs.microsoft.com/en-us/dotnet/
   - **ii.** https://msdn.microsoft.com/en-us/library/ff361664(v=vs.110).aspx
   - **iii.** https://msdn.microsoft.com/en-us/library/aa286485.aspx
   - **iv.** https://blogs.msdn.microsoft.com/dotnet/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment		Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (C# and VB.NET)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	3	2	2	3	2	2	2	3	1	3	**2.4**
CO-2	3	3	3	2	3	2	3	2	2	3	21	3	**4.2**
CO-3	3	3	3	2	3	3	2	2	3	3	1	3	**2.6**
CO-4	3	3	3	2	3	3	2	2	2	3	1	3	**2.5**
CO-5	3	3	3	2	3	3	2	2	2	3	1	3	**2.5**
Average	**3**	**3**	**3**	**2**	**2.8**	**2.8**	**2.2**	**2**	**2.2**	**3**	**5**	**3**	

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Data Structure and Software Design

COURSE CODE: 18B1WCI631

COURSE CREDITS: 2

CORE/ELECTIVE: ELECTIVE

L-T-P: 2-0-0

Pre-requisites: Data Structures, Compilers, Operating Systems, Computer Networks, Machine Learning and Genetic Algorithms.

Course Objectives:

1. Apply array and stack data structures in mathematical problem solving and implementing various compiler and operating systems mechanisms, respectively.
2. Apply queue and linked list to implement various compiler and operating systems mechanisms.
3. Apply tree and graphs to implement various compiler, computer networks and real time google map applications.
4. Apply priority queue to implement scheduling jobs, sorting huge files and shortest path computation. Apply hashing in implementation of programming languages, file systems, pattern search, and distributed system concepts.
5. Apply data structures in Computer Networks, databases, and image & computer vision.
6. Understanding data structures used in audio/video files, 2D/3D maps, and machine learning & genetics.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	To learn to apply array and stack data structures in mathematical problem solving and implementing various compiler and operating systems mechanisms, respectively.	Assessment
CO-2	To learn to apply queue and linked list to implement various compiler and operating systems mechanisms.	Assessment
CO-3	To learn to apply Apply tree and graphs to implement various compiler, computer networks and real time google map applications.	Assessment
CO-4	To learn to apply priority queue to implement scheduling jobs, sorting huge files and shortest path computation. Apply hashing in implementation of programming languages, file systems, pattern search, and distributed system concepts.	Assessment
CO-5	To learn to apply data structures in Computer Networks, databases, and image & computer vision.	Assessment
CO-6	To learn and understand data structures used in audio/video files, 2D/3D maps, and machine learning & genetics.	Usage

Course Contents:

Unit	Contents	Lectures required
1	**Arrays:** finding maximum, minimum, mean, median, average; performing operations – sorting, merging, traversal and retrieval; representing matrices in computer‟s memory for solving many complex mathematical problems and image processing transformations **Stacks:** evaluating arithmetic expressions, storing function arguments and local data as programs are executed, storing local variables used inside a function block in compilers/operating systems, undo mechanisms in text editors, backtracking in a series of elements, parsing computer languages in compilers, processing	7

	function calls and implementing recursive functions, creating space for parameters and local variables in language processing, compiler‟s syntax check for matching braces	
2	**Queues:** interrupts in operating system, how application programs store incoming data, process synchronization in operating system, CPU job scheduling and disk scheduling, **Linked lists:** dynamic memory management, representing polynomials and performing addition, subtraction, multiplication, etc. with polynomials, symbol tables for balancing parenthesis and representing sparse matrix	**5**
3	**Trees:** syntax validation in compilers, implementing sorted dictionary, usage in Internet protocols, storing router tables, quick traversal and searching of directory structures **Graphs:** representing link structure of a website using directed graph, job scheduling problems of CPU, simultaneous execution of jobs problem between set of processors and set of jobs, real time applications of data structures: determination of cities using google maps to find population, finding addresses on maps	**5**
4	**Priority queues:** efficiently schedule jobs (either in the context of a computer operating system or in real life), sorting huge files (which are the most important building block for any Big Data processing algorithm), and efficiently computing shortest paths in graphs. Minimum spanning trees greedy algorithms: Kruskal‟s and Prim‟s **Hashing:** implementating file systems, pattern search, distributed key-value storage, hash functions used in modern distributed systems optimizing storage of services like Dropbox, Google Drive and Yandex Disk!	**5**
5	**Data structure for Computer Networks-** Routing tables, DNS Query, IP Config, Netstat, Address IP, Hashing for MAC tables, protocols **Data structure for popular databases:** Representing indexes with B- trees, buffer trees, quad trees, R-trees, interval trees, hashing etc. **Image & Computer Vision-** Data structure for image representation, pattern recognition, for object recognition – face, house activity analysis, Disjoint sets data structure in dynamic graph connectivity and image processing	**5**
6	**Data structure for video and audio systems:** Video – MPEG-4 Video File (.mp4), MPEG Video File (.mpg), Adobe Flash Video (.flv), Windows Media Video File (.wmv), Uncompressed Audio Formats – Waveform Audio File Format (WAV), Audio Interchange File Format (AIFF), Lossy Compressed Audio Formats – MPEG-1 Audio Layer-3 (MP3), Windows Media Audio (WMA), Lossless Compressed Audio	**5**
	Formats – Free Lossless Audio Codec (FLAC), Apple Lossless Audio Codec (ALAC), Windows Media Audio (WMA). **Data structure for 2D/3D maps:** Vector and Raster data structures, Entity-by-entity data structure (point, line, area), Topological data structures, Tessellations and the tin, Quad Trees, Maps as matrices, Map and attributes **Learned Data structures for machine learning algorithms:** Learned indexes (Cumulative Distribution Functions (CDFs)), Learned Hash-Maps, Learned Bloom filters, Comparison of traditional and learned data structures. Introduction to data structure for genetics	
Total lectures		**32**

Suggested Text Book(s):

1. Horowitz and Sahani: Fundamental of Data Structures in C, 2nd Edn, 2008

Suggested Reference Book(s):

Approved in Academic Council held on 25.10.2018

1. Data structures and network algorithms by Robert Endre Tarjan, Society for Industrial and Applied Mathematics (SIAM), ISBN-0-89871-187-8.
2. Computer Networks, 5th edition, Andrew S. Tanenbaum and David J. Wetherall, Pearson Education.
3. Data structure and operating system (Wiley series in computing) by Teodor Rus, John Wiley & Sons Ltd., ISBN-13: 978-0471995173
4. Compiling Techniques by F.R.A. Hopgood, Macdonalds http://www.chilton-computing.org.uk/acl/literature/books/compilingtechniques/contents.htm
5. Compiler construction by William M. Waite and Gerhard Goos, Springer Verlag, ISBN-0-387-90821-8.
6. Data Structures for Databases by Jaochim Hammer and Markus Schneider, https://www.cise.ufl.edu/~mschneid/Research/papers/HS05BoCh.pdf
7. Genetic Algorithms + Data Structures = Evolution Programs by Zbigniew Michalewicz, Springer, ISBN-3-540-60676-9 and ISBN-3-540-58090-5 (2nd edition).
8. Algorithms for graphics and image processing by Theo Pavlidis, Computer Science Press , Inc. Fundamentals of Database Systems" Elmasri, Navathe, Pearson Education.
9. "Database system concepts" Henry F Korth, Abraham Silberschatz, S. Sudurshan, McGraw-Hill
10. Deo, N., Graph Theory with Applications to Engineering and Computer Science, Prentice-Hall, 1974.
11. Digital Image Processing, R.C. Gonzalez and R.E. Woods, 2nd edition, Pearson Prentice Hall, 2008
12. Operating System Concepts by Silberschatz and Galvin, 9th Edition, John Wiley & Sons.

Other useful resource(s):

1. Data structure for 2D/3D maps: http://www.geog.ucsb.edu/~kclarke/AACC/Chapter08.pdf
2. Audio Formats : https://www.makeuseof.com/tag/audio-file-format-right-needs/Video Formats :
3. https://www.lcps.org/cms/lib/VA01000195/Centricity/Domain/1349/Resources/Video_file_formats.pdf

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment		Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Data Structure and Software Design)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	3	3	2	3	3	2	3	2	3	3	**2.8**
CO-2	3	3	3	3	2	3	3	2	3	2	3	3	**2.8**
CO-3	3	3	3	3	2	3	3	2	3	2	3	3	**2.8**
CO-4	3	3	3	3	2	3	3	2	3	2	3	3	**2.8**
CO-5	3	3	3	3	2	3	3	2	3	2	3	3	**2.8**
CO-6	3	2	2	3	3	3	3	2	3	2	3	3	**2.7**
Average	**3**	**2.8**	**2.8**	**3**	**2.2**	**3**	**3**	**2**	**3**	**2**	**3**	**3**	

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Software Testing Fundamentals Lab

COURSE CODE: 18B1WCI673

COURSE CREDITS: 1

CORE/ELECTIVE: ELECTIVE

L-T-P: 0-0-2

Pre-requisite: Object Oriented Analysis and Design with UML, Software Engineering, Software Metrics, Basics of Mathematics.

Course Objectives:

1. Have an ability to apply software testing knowledge and engineering methods.
2. Have an ability to design and conduct a software test process for a software testing project.
3. To learn how to planning a test project, design test cases and data, conduct testing operations, manage software problems and defects, generate a testing report.
4. To discuss various software testing issues and solutions in software unit test; integration, regression, and system testing.
5. To gain the techniques and skills on how to use modern software testing tools to support software testing projects.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Have an ability to apply software testing knowledge and engineering methods.	Familiarity
CO-2	Have an ability to design and conduct a software test process for a software testing project.	Usage
CO-3	Have an ability to identify the needs of software test automation, and define and develop a test tool to support test automation.	Assessment
CO-4	Have an ability understand and identify various software testing problems, and solve these problems by designing and selecting software test models, criteria, strategies, and methods.	Assessment
CO-5	Have an ability to use various communication methods and skills to communicate with their teammates to conduct their practice-oriented software testing projects.	Usage
CO-6	Have basic understanding and knowledge of contemporary issues in software testing, such as component-based software testing problems.	Usage
CO-7	Have an ability to use software testing methods and modern software testing tools for their testing projects.	Usage

List of Experiments:

S. No	Description	Hours
1	Revision of Java coding using Eclipse	**2**
2	Developing Black box test cases 1: a) Using Boundary Value Analysis	**2**
3	Developing Black box test cases 2:	
	a) Using Equivalent Classes	**2**
4	Developing Black box test cases 3: a) Using DecisionTables	**2**

5	Developing WhiteBox test cases 1: a) Performing Path testing	**2**
6	Developing WhiteBox test cases 2: a) Performing orthogonal testing	**2**
7	Developing WhiteBox test cases 3: a) Performing Coverage Analysis	**2**
8	Mutation testing and developing Mutants	**2**
9	Regression testing and Developing Regression test Cases	**2**
10	Performing GUI testing for a designed application	**2**
11	Performing Load testing for a designed application	**2**
12	Getting familiar with Profiler and performing CPU, Memory analysis in real time	**4**
Total Lab Hours		**26**

Suggested Books/Resources:

1. 1. A Practitioner"s Guide to Software Test Design, Lee Copeland, 2003,
2. The Art of Software Testing, 2nd edition, Glenford Myers, et. el., 2004
3. Software Testing Techniques, 2nd edition, Boris Beizer, 1990
4. How to Break Software: A Practical Guide to Testing, James Whittaker, 2002.
5. Testing Object-Oriented Systems: Models, Patterns, and Tools, Robert V. Binder, 1999.
6. Software Testing and Quality Assurance: Theory and Practice Paperback – 2010

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Attendance	15 Marks
4	Lab Assessment	45 Marks
	Total	100 marks

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Average
CO-1	3	2	3	2	2	3	3	3	2	3	2	2	**2.5**
CO-2	3	3	3	2	3	3	3	3	2	3	2	3	**2.8**
CO-3	3	3	3	2	2	3	3	3	3	3	2	2	**2.7**
CO-4	3	3	3	3	3	3	3	2	2	3	3	3	**2.8**
CO-5	3	3	3	2	2	2	3	3	3	3	2	2	**2.6**
CO-6	3	3	3	3	3	3	3	2	2	3	3	3	**2.8**
CO-7	3	3	3	3	3	3	2	2	3	3	3	3	**2.8**
Average	**3**	**2.9**	**3**	**2.4**	**2.6**	**2.9**	**2.9**	**2.6**	**2.4**	**3**	**2.4**	**2.6**	

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Computer Aided Civil Engineering Drawing

COURSE CODE:18B11CE413

COURSE CREDITS: 1

CORE/ELECTIVE: CORE

L-T-P: 0-0-2

Pre-requisite: None

Course Objectives:

1. To learn the fundamentals of civil engineering drawings.
2. To develop knowledge of civil engineering software tools such as AutoCAD.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO1	To be able to understand and interpret Civil Engineering Drawings.	Familiarity
CO2	Learn and master basic skills in AutoCAD.	Assessment
CO3	Understand basics of multidisciplinary engineering drawings such as mechanical, electrical, plumbing drawings.	Assessment
CO4	To gain proficiency in planning and developing drawings for small residential buildings.	Usage
CO5	Comprehend the basics of building information modeling.	Usage

List of Experiments:

S.No.	Description	Hours
1	Introduction and interpretation to concept of engineering drawings using AutoCAD (Basic drawing entity commands.	**2**
2	Entity modification commands, Layers, Text and Dimensioning, Blocks. Drawing presentation norms and standards and other advance commands.	**4**
3	Materials, Architectural, Structural, Electrical and Plumbing symbols drawing and interpretation using AutoCAD.	**2**
4	Rebar drawings and structural steel fabrication and connections drawing symbols, welding symbols; dimensioning standards.	**2**
5	English Bond and Flemish Bond – Corner wall and Cross walls - One brick wall and one and half brick wall.	**2**
6	Elements of planning building drawing, Methods of making line drawing and detailed drawing.	**2**
7	Site plan, floor plan, elevation and section drawing of small residential buildings.	**4**
8	Foundation plan. Roof drainage plans.	**2**

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9	Standard fittings and fixtures, finishes.	**2**
10	Principles of isometrics and perspective drawing, Perspective view of building	**4**
11	Fundamentals of Building Information Modelling (BIM).	**2**
Total Lab hours		**28**

Suggested Text Book(s):

1. Engineering Graphics with AutoCAD by Kulkarni, Dhananjay M., A. P. Rastogi, and Ashoke K. Sarkar. PHI Learning Pvt. Ltd., 2009.
2. Civil Engineering Drawing by Rangwala and Dalal 3rd edition 2017
3. Civil Engineering Drawing & House Planning: A Text Book, by B.P Verma 2006
4. Building Information Modeling for Dummies by Stefan Mordue, 2015

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Attendance	15 Marks
4	Lab Assessment	45 Marks
	Total	100 marks

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course Outcomes (Computer Aided Civil Engineering Drawing)	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**Average**
CO1	3	2	3	2	1	2	2	1	3	3	1	3	**2.17**
CO2	3	2	3	3	3	2	x	x	3	2	x	3	**2.67**
CO3	2	2	2	2	1	2	3	2	2	2	2	3	**2.08**
CO4	2	2	3	2	1	2	2	1	2	1	2	2	**1.83**
CO5	2	1	2	2	3	2	2	1	3	2	3	2	**2.08**
Average	**2.4**	**1.8**	**2.6**	**2.2**	**1.8**	**2**	**2.25**	**1.25**	**2.6**	**2**	**2**	**2.6**	

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Cell Biology & Cell Culture Technologies

COURSE CODE:18B11BT411

COURSE CREDITS: 4

ELECTIVE/CORE: CORE

: 3-1-0

Pre-requisite: Basic Understanding of Biology

Course Objectives:

1. The objective of this course is to introduce the student to basic cell biology, animal & plant tissue culture techniques and their application.
2. In cell biology component, the course is designed to understand fundamental concepts of cell and how it functions at the cellular level.
3. In animal tissue culture component, the course is designed to impart an understanding pertaining to why one needs animal cell cultivation, the basic ATC set-up, the biology of cultured cells, techniques to establish and propagate cell cultures of animal origin.
4. In plant tissue culture component, the course is designed to develop an understanding about the morphology of plant cell and its utilization through different techniques of plant tissue culture for propagation, conservation and production of different plant species and their products

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Successful student will understand fundamental concepts of cellular function.	Familiarity
CO-2	Be able to critically analyze, the scientific evidence underlying current understanding of cellular processes.	Assessment& Analytical Skills
CO-3	To enable students for applying the knowledge about basic techniques of plant tissue culture.	Technical Skills
CO-4	They will learn the strategies for analyzing, upscaling and commercialization of plant based products.	Technical Skills
CO-5	Basic understanding of animal tissue culture, Maintain aseptic condition, primary and continuous culture of cell lines, suspension and adherent cells, cryopreservation and revival of cell lines.	Awareness
CO-6	To understand functional assay at cellular level, cell morphology and survival, immunolabeling.	Analytical & Technical Skills

Course Contents:

Units	Contents	Lectures required
1	Introduction to the cell Prokaryotic and Eukaryotic cell; Animal and Plant cell, Structure of cell, cellular organelles and their structure and function. Biological membranes – Overview of Membrane structure and function - Structure of model membrane, lipid bilayer and membrane protein diffusion, osmosis, ion channels, active transport, membrane pumps, Protein Sorting, Intracellular Vesicular Traffic and regulation of intracellular transport, electrical properties of membranes.	**3**

2	Cell signalling - Hormones and their receptors, cell surface receptor, signaling through G-protein coupled receptors, signal transduction pathways, second messengers and regulation of signaling pathways. The Cytoskeleton, Cell Cycle and Programmed Cell Death, Cell adhesion and roles of different adhesion molecules, gap junctions, extracellular matrix, integrins, neurotransmission and its regulation. Methods and techniques - Manipulating proteins, DNA and RNA. Visualizing cells.	**8**
3	Plant structure, growth and development Introduction, definitions and history of plant cell and tissue culture Organization of tissue culture laboratory Cellular totipotency and cell differentiation, factors affecting differentiation	**8**
4	Isolation of single plant cells, suspension cultures, types of suspension cultures, Measurement of the growth in suspension cultures, Assessment of Viability of the cultured cells, bioreactors used for plant cell cultures	**8**
5	Type of cultures and their applications: Direct and indirect methods of culture; seed culture, embryo culture, organ culture, callus culture, somaclonal variation and applications	**7**
6	Somatic embryogenesis Micro-propagation and its applications, Advances in acclimatization of tissue cultured plants. Haploid and triploid production and applications Protoplast isolation and fusion and application Production of virus free plants through cell and tissue culture	**4**
7	Secondary metabolite production and bioconversions /biotransformation through plant cell cultures and plant stem cells	**4**
8	Introduction to human anatomy and Physiology, An overview of different Systems, organs and tissues of human body. Basics terms and definitions, historical background, Importance of animal cell culture technology, laboratory facilities-design, equipments and safety parameters, waste disposal in a cell culture set-up. Aseptic techniques for animal cell cultivation.	
9	Cell culture technology: Basic requirement for growing animal cells - Cell culture reagents, media, media supplements, media preparation and sterilization, Defined-Undefined media, Complete-Incomplete media, Importance of Serum and Serum free Media, culture conditions. Maintenance of cell culture: Culturing, sub- culturing, passaging.	
10	Studying biological system using cell culture techniques: Functional assays based on cell culture: Cell morphology, Quantitation, Growth pattern, Cytotoxicity assays, Study of Cell Death: senescence, apoptosis and necrosis, Cell proliferation, Cell viability measurements, FISH. Immunolabeling of cells to study molecular expression pattern– Microscopy, Flow cytometry, Immunohistochemistry, etc. Application of Cell culture Technology Hybridoma technology for monoclonal antibody production.	
Total Lectures		**42**

Suggested Text Book(s):

1. Michael Butler, "Animal Cell Culture and Technology", BIOS Scientific Publishers
2. John R.W. Masters, " Animal Cell Culture-A Practical Approach", Oxford University Press
3. R. Ian Freshney, "Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications".

4. Introduction to Plant biotechnology H S Chawala
5. Plant tissue culture: theory and Practice S.S.Bhojwani and M K Razadan
6. Plant tissue culture S.S.Bhojwani and M K Razadan
7. Elements of Biotechnology P K Gupta
8. Plant cell and tissue culture Narayan Swamy

Suggested Reference Book(s)

1. Molecular Biology of the Cell: by Bruce Alberts, 4th Edition 2002.
2. Lodish, et al. Molecular Cell Biology. 5th ed. New York, NY: W.H. Freeman and Company, 2003.

Other useful resource(s):

1. Link to NPTEL course contents:https://nptel.ac.in/
2. https://nptel.ac.in/courses/102103012/
3. https://nptel.ac.in/courses/102104059/
4. https://nptel.ac.in/courses/102103016/

EvaluationScheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment, Quizzes&Attendance

Course Outcomes (COs) contribution to the ProgrammeOutcomes(POs)

Course outcomes (Cell Biology & Cell Culture Technologies)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	2	2	1	1	1	2	2	**1.75**
CO-2	2	2	2	2	2	2	1	1	1	1	2	2	**1.66**
CO-3	3	3	3	3	2	1	2	1	1	1	2	2	**2**
CO-4	3	3	3	3	2	1	2	1	1	1	2	2	**2**
CO-5	2	2	2	2	2	2	1	1	1	1	2	2	**1.66**
CO-6	3	3	3	3	2	2	1	1	1	1	2	2	**2**
Average	**2.5**	**2.5**	**2.5**	**2.5**	**2**	**1.6**	**1.5**	**1**	**1**	**1**	**2**	**2**	

Cell Biology & Cell Culture Technologies Lab

COURSE CODE: 18B17BT471

COURSE CREDITS: 1

CORE/ELECTIVE: CORE

L-T-P: 0-0-2

Pre-requisite: Basic Biology

Course Objectives:

4. The objective is to familiarize students with the various Cell biology and cell culture techniques.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO1	To understand, design, analyze and interpret experiments related to cell biology and link practical knowledge to theoretical.	Familiarity
CO2	To understand, design, analyze and interpret experiments related to Animal cell culture and link practical knowledge to theoretical	Analytical Skills
CO3	To understand, design, analyze and interpret experiments related to Plant tissue Culture and link practical knowledge to theoretical	Analytical Skills
CO4	Able to perform cell count using haemocytometer and maintain aseptic condition.	Technical Skills
CO5	To understand team work, ethics and work discipline.	Use

List of Experiments

S.No	Description	Hours
1	Laboratory Safety and To Study various parts of compound microscope	2
2	To prepare and study temporary or permanent slides of mitosis, meiosis, stem and root cells/sections and differentiate the plant cells and animal cells	2
3	To study the effect of salinity on biological membranes of cells	2
4	To prepare the blood smear slides, visualization and cell count of the components of blood using light microscopy	2
5	Introduction to ATC, Fluid Transfer using aseptic technique, Preparation of stock media from powder and filter sterilization	2
6	Sub culturing, Cryopreservation and Revival of Cell culture	2
7	Assessment of cytotoxicity using MTT assay/Biological screening of herbal/synthetic molecules.	2
8	Introduction to various equipments and their working in plant tissue culture lab setup and Preparation of stocks solutions, hormones culture medium	2
9	Establishment of Callus and Suspension cultures and measuring cell	2

	growth	
10	Plant regeneration from callus and somatic embryogenesis	2
11	Microproapagation of different plant species by axillary shooting	2
12	Hardening or Acclimatization of cultured plantlets to field conditions	2
13	Meristem culture for virus elimination. Anther and pollen culture for haploid production	2
14	Protoplast isolation and determining the protoplast viability	2
Total Lab hours		**28**

Suggested/Resources:

1. Lab Manual
2. Plant Cell and Tissue Culture - A Tool in Biotechnology: Basics and Application (Principles and Practice) by: Karl-Hermann Neumann publisher: Springer
3. Tissue Culture for Plant Propagators by R.A. de Fossard
4. Plant Culture Media, Volume 1,Formulations and Uses by E.F. George
5. Micropropagation: Technology and Application by P.C. Debergh and R.H. Zimmerman Kluwer Academic Publishers
6. Virtual Lab. (http://vlab.amrita.edu)

EvaluationScheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Lab Assessment	60 Marks
	Total	100 marks

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Average
CO1	3	3	3	3	2	2	1	1	1	1	1	1	**1.83**
CO2	3	3	3	3	3	1	1	1	1	1	1	3	**2.00**
CO3	3	3	2	3	2	3	2	1	1	1	2	1	**2.00**
CO4	3	3	3	2	3	2	1	1	1	1	1	1	**1.83**
CO5	2	2	3	3	3	3	1	1	1	1	1	1	**1.83**
Average	**2.8**	**2.8**	**2.80**	**2.80**	**2.60**	**2.20**	**1.20**	**1.00**	**1.00**	**1.00**	**1.20**	**1.40**	

Compiler Design

COURSE CODE: 18B11CI612

COURSE CREDITS: 3

CORE/ELECTIVE: CORE

: 3-0-0

Pre-requisites: Perquisite for this course is programming languages like C, C++, java and basic knowledge of formal language and automata theory. This is a programming-intensive course. The primary languages used are C and Java and familiarity with them is assumed.

Course Objectives:

1. To understand the basic concept of compilation particular, lexical analyzer, syntax and semantic analysis, code generation and optimization phases of compilation.
2. Ability to create lexical rules and grammars for a programming language.
3. Ability to use flex or similar tools to create a lexical analyzer and Yacc/Biscon tools to create a parser
4. Ability to implement a various parser such as a bottom-up SLR parser without using any compiler-generation tools
5. Ability to implement a various intermediate code generation techniques without using any compiler generation tools
6. Ability to implement various code optimizing techniques without using any compiler-generation tools
7. Ability to implement semantic rules into a parser that performs attribution while parsing
8. Ability to design a compiler for a concise programming language.

Course Outcomes

S. No.	Course Outcomes	Level of Attainment
CO-1	To understand the basic concept of compilation particular, lexical analyzer, syntax and semantic analysis, code generation and optimization phases of compilation	Familiarity
CO-2	Ability to create lexical rules and grammars for a programming language	Familiarity
CO-3	Ability to use flex or similar tools to create a lexical analyzer and Yacc/Biscon tools to create a parser	Computational skills
CO-4	Ability to implement a various parser such as a bottom-up SLR parser without using any compiler-generation tools	Technical skills
CO-5	Ability to implement a various intermediate code generation techniques without using any compiler generation tools	Technical skills
CO-6	Ability to implement various code optimizing techniques without using any compiler-generation tools	Technical skills
CO-7	Ability to implement semantic rules into a parser that performs attribution while parsing	Assessment
CO-8	Ability to design a compiler for a concise programming language	Assessment

Course Contents:

Unit	Contents	Lectures required
1	**Introduction:** Compilers, Analysis of Source Program, Phases of Compiler, Issues in a Compiler Structure, Major Data Structures in Compiler, Bootstrapping and Porting	**3**
	Lexical Analysis: Role of the Lexical Analyzer, Scanning Process- Input Buffering, Specification of Tokens, Recognition of Tokens, Regular Language,	

2	Finite Automata, Regular Expression, Regular Expression to Finite automata, Scanner Generator (lex, flex)	**4**
3	**Syntax Analysis:** Parsing Process, Context-Free Grammar, Handle, Ambiguity, Parse Tree, Push-Down Automata , Top Down Parsing: Basic Concept, Recursive Descent Parsing, First Function, Follow Function, Conflicts-Shift Reduce, Reduce-Reduce, LL(1) Grammar, LL(1) Parser, Error Recovery, Bottom up parsing :Basic Concept, Shift Reduce Parsing, Operator Grammar, Operator Precedence Parsing, Augmented Grammar, LR(0) Item Set, LR(0) Parsing, LR(1) Item Set, SLR(1) Parsing, Canonical LR Parser, LALR parsing, Error Recovery, YACC and BISON	**12**
4	**Semantic Analysis:** Syntax-Direct Definitions, Implementation of Syntax-directed Translators, Bottom-up Evaluation of S-attributed Definitions, L-attributed Definitions, and Top-down Translation	**5**
5	**Intermediate Code Generation:** Postfix Notation, Parse Trees & Syntax Trees, Three Address Code, Quadruple & Triples, Translation of Assignment Statements, Boolean Expressions, Statements That Alter Flow of Control, Postfix Translation, Array References in Arithmetic Expressions, Procedures Call, Declarations and Case Statements	**5**
6	**Code Generation: Issues** in the design of a Code Generator, Target Machine, Run-Time Storage Management, Basic blocks and Flow graphs	**4**
7	**Code Optimization:** Machine-Independent Optimizations, Machine Dependent Optimization, Loop optimization, DAG representation of basic blocks, value numbers and algebraic laws, Global Data-Flow analysis	**5**
8	**Run-time environment and Symbol:** Procedure activation, parameter passing, value return, memory allocation, and scope, Symbol Table, Definition, Structure, Types, symbol attributes and management	**4**
Total Lectures		**42**

Suggested Text Book(s):

1. Compilers: Principles, Techniques, and Tools by Alfred V. Aho, Monica S. Lam, Ravi Sethi, and Jeffrey D. Ullman, Pearson Publisher
2. Compiler Construction, Kenneth C. Louden, 582 pages
3. Modern Compiler Implementation in C, Andrew W. Appel, 544 pages

Suggested Reference Book(s):

1. http://ecomputernotes.com/compiler-design
2. http://www.diku.dk/~torbenm/Basics/basics_lulu2.pdf

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment		Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Compiler Design)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	2	2	1	2	3	3	2	1	3	2	1	**2.1**
CO-2	3	3	2	1	1	3	3	1	3	3	3	1	**2.3**
CO-3	3	3	2	1	2	2	2	1	2	3	3	2	**2.2**
CO-4	3	3	3	2	2	2	3	2	2	1	2	2	**2.3**
CO-5	3	3	3	2	2	2	2	2	1	3	2	1	**2.2**
CO-6	3	3	3	3	2	3	3	2	2	3	2	2	**2.6**
CO-7	3	3	3	3	2	3	3	1	2	3	2	2	**2.5**
CO-8	3	3	3	3	2	3	3	2	2	2	3	2	**2.6**
Average	**3**	**2.9**	**2.6**	**2**	**1.9**	**2.6**	**2.8**	**1.6**	**1.9**	**2.6**	**2.4**	**1.6**	

Computer Networks

COURSE CODE: 18B11CI611

COURSE CREDITS: 3

CORE/ELECTIVE: CORE

: 3-0-0

Pre-requisites: None

Course Objectives:

1. The course introduces the concepts and fundamental design principles of modern computer networking, focusing on the Internet‟s architecture and protocols.
2. The course introduces the concepts of data and computer communications, computer network introduction and its applications in our real life.
3. Reference models such as OSI and TCP/IP and its way toward the physical layer concepts, data link layer and its protocols, multiple access protocols.
4. Provide students Network layer and its different routing protocols, the concepts/design of IP addressing.
5. To provide students Transport layer and its protocols such as TCP, UDP and SCTP to application layer and its protocol such as HTTP, FTP, SMTP and DNS.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	To learn the basic concepts and terminology in computer networks	Familiarity
CO-2	To learn about the layered models in computer networks and different types of network topologies and protocols	Assessment
CO-3	To learn about the data link layer and MAC layer protocols and related issues	Assessment
CO-4	To learn concepts associated with subnetting and routing mechanisms. Understand network industry standards such as: Routing Protocols, Address Resolution and Reverse Address Resolution Protocols, IP Addresses and Subnetting, MAC Addressing.	Assessment
CO-5	To learn about the transport layer protocols and related issues	Assessment
CO-6	You will learn about the session, presentation and application layers protocols.	Usage
CO-7	Further, to learn about the some advanced topics in networks such as Cryptographic algorithms, Network security and management, and concepts of wireless networks	Familiarity

Course Contents:

Unit	Contents	Lectures required
1	**Introduction to Computer Networks**: Network Software Architecture: layers and protocols, OSI vs. TCP, Network Model, Connection Oriented and Connectionless services, Network Topology, Delay.	4
2	**Physical Layer:** Transmission Terminology, Analog and Digital Signal, Transmission Impairments, Transmission Media, Modulation, Switching Techniques, Multiplexing Techniques	8

3	**Data Link Layer:** Introduction and services to Data Link layer, Error detection and Correction techniques, Bit and Byte stuffing, Bit/Byte oriented protocol, Flow Control Mechanism, Multiple access protocol, Ethernet, Hubs and switches, Router and Gateways.	**8**
4	**Network Layer:** Network service model, Virtual circuit and Datagram networks, Logical Addressing and Sub-netting, Internet protocol: IPv4 and IPv6, ARP vs RARP, DHCP, Routing algorithms and standards, Internetworking, The network layer in the internet, Broadcast and multicast routing, Congestion Control Algorithms,	**8**
5	**Transport Layer:** Transport layer services and principles, End-to-end protocols: Issues and services, Multiplexing and De-multiplexing, Connectionless transport: UDP, Principles of reliable data transfer, Connection-oriented Transport: TCP, SCTP, Principles of congestion control, TCP Congestion Control, Quality of services.	**8**
6	**Application Layer:** Principle of application layer protocols, WWW and HTTP, FTP, Telnet, SMTP, DNS etc.	**3**
7	**Some Advanced Topics:** Symmetric-key algorithms, Public key algorithms, RSA, Digital Signatures, Communication security, authentication protocols, Web security, Wireless LAN, Mobile IP, Introduction to Multimedia networking, Network management.	**3**
Total lectures		**42**

Suggested Text Book(s):

1. Andrew S. Tanenbaum, "Computer Networks" 4th Edition PHI
2. James F. Kurose, Keith W. Ross, "Computer Networking: A Top-Down Approach Featuring the Internet" 3rd Edition Pearson Education

Suggested Reference Book(s):

1. UNIX Network Programming, Volume 1, Second Edition: Networking APIs: Sockets and XTI, Prentice Hall, 1998, ISBN 0-13-490012-X.
2. Arnold Robbins, "UNIX in a Nutshell", O"Reilly 4th Edition
3. David I. Schawartz, "Introduction to UNIX", Prentice Hall, Second Edition
4. BEHROUZ a. Forouzan and Richard F. Gilberg, "UNIX and Shell Programming: A Textbook"
5. NS Simulator for Beginner"s, Lecture notes Univ. de Los Andes, France.
6. Angela Orebaugh, Gilbert Ramirez,Josh Burke, Larry Pesce, Joshua Wright, Greg Morris, "Wireshark & Ethereal Network Protocol Analyzer Toolkit", Syngress Publishing, Inc.

Other useful resource(s):

3. Link to topics related to course:
   i. https://www.coursera.org/specializations/networking-basics
   ii. https://nptel.ac.in/courses/106105080/
   iii. https://swayam.gov.in/course/4066-computer-networks

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment		Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Approved in Academic Council held on 25.10.2018

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Computer Networks)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	3	2	2	3	2	2	2	3	1	3	**2.4**
CO-2	3	3	3	2	3	2	3	2	2	3	1	3	**2.5**
CO-3	3	3	3	2	2	3	1	2	3	3	1	3	**2.4**
CO-4	3	3	3	2	3	3	2	2	3	3	1	3	**2.6**
CO-5	3	3	3	2	3	3	2	2	3	3	1	3	**2.6**
CO-6	3	3	3	2	3	3	2	2	2	3	1	3	**2.5**
CO-7	3	3	3	2	2	3	3	2	2	3	1	3	**2.5**
Average	**3**	**3**	**3**	**2**	**2.6**	**2.9**	**2.1**	**2**	**2.4**	**3**	**1**	**3**	

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Compiler Design Lab

COURSE CODE: 18B17CI672

COURSE CREDITS: 2

CORE/ELECTIVE: CORE

: 0-0-4

Pre-requisite: An understanding in Theory of computation, Introduction to any programming language (Preferably, C)

Course Objectives:

1. The lab course provides the complete description about inner working of a compiler.
2. The main focus is on the design of compilers and optimization techniques.
3. The course also aims to convey the language specifications, use of regular expressions and context free grammars behind the design of compiler.
4. It builds an understand ability of various parsing techniques like predictive parsing, LR parsing, LALR parsing. It also focuses on the design of Compiler writing tools.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Gain an in-depth understanding of the principles underlying the design	Familiarity
CO-2	Construction of compilers	Familiarity
CO-3	Functioning of Compiler writing tools	Computational skills
CO-4	Building various parsing techniques	Technical skills

List of Experiments:

S. No.	Description	Hours
1	a. Write a program to read and translate integers into numbers. e.g. 1=ONE 12 = ONE TWO 856 = EIGHT FIVE SIX Generate an error if the number of digits is more than 3 b. Write a program to convert infix notation to postfix notation.	4
2	1. Implement a DFA which simulates the regular expression a + (aa)*b. 2. The following rules define the translation of an English word into pig Latin: a) If the word begins with a nonempty string of consonants, move the initial consonant string to the back of the word and add the suffix AY; e.g., pig comes igpay. b) If the word begins with a vowel, add the suffix YAY; e.g., owl becomes owlyay. c) U following a Q is a consonant.	8

	d) Y at the beginning of a word is a vowel if it is not followed by a vowel. e) One-letter words are not changed. Write a C program to generate pigLatin from an English word.	
3	Implementation of Lexical analysis	4
4	Program for computation of FIRST AND FOLLOW of non-terminals.	4
5	Write a program to check whether a grammar is left recursive or not, if it is remove left recursion.	4
6.	Implementation of Predictive Parsing Table Construction	6
7.	Implementation of Shift Reduce Parsing	6
8.	Implementation of Operator Precedence Parsing	6
9.	Implementation of LR Parsing	4
10	Intermediate Code Generation	4
11	Implementation of Code Generation	4
Total Lab hours		**56**

Suggested Books/Resources:

1. Compilers : Principles, techniques and tools, Aho, Sethi and Ullman
2. Compiler design in C, Holub
3. Advanced compiler design and implementation, Muchnick, Morgan and Kauffman

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Attendance	15 Marks
4	Lab Assessment	45 Marks
	Total	100 marks

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Average
CO-1	3	2	2	1	2	3	3	2	1	3	2	1	**2.1**
CO-2	3	3	2	1	1	3	3	1	3	3	3	1	**2.3**
CO-3	3	3	2	1	2	2	2	1	3	3	3	2	**2.3**
CO-4	3	3	3	2	2	2	3	2	2	1	2	2	**2.3**
Average	**3**	**2.8**	**2.3**	**1.3**	**1.8**	**2.5**	**2.8**	**1.5**	**2.3**	**2.5**	**2.5**	**1.5**	

Computer Networks Lab

COURSE CODE: 18B17CI671

COURSE CREDITS: 2

CORE/ELECTIVE: CORE

: 0-0-4

Pre-requisite: None

Course Objectives:

1. To implement important computer networking protocols in a high – level programming language.
2. To understand the working principle of various communication protocols.
3. To analyze the various routing algorithms.
4. To know the concept of data transfer between nodes.
5. To become acquainted with socket programming and some of the important computer networking tools.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	To understand the working concepts of Networking and inter – networking Devices.	Familiarity
CO-2	To understand the concepts of different shortest path algorithms.	Assessment
CO-3	To understand different error detection and correction techniques/algorithms.	Assessment
CO-4	To understand Flow control techniques/algorithms.	Assessment
CO-5	To understand the concepts of client – server interaction using connection oriented and connectionless protocols.	Assessment
CO-6	To understand the proficiency in Traffic Shaping Algorithms.	Usage
CO-7	You shall be exposed to working of encryption and decryption algorithms.	Familiarity

List of Experiments:

S. No.	Description	Hours
1	Representation of a computer network using matrix representation of a graph	4
2	Finding shortest path between any two nodes in a computer network using Dikjstra‟s shortest path algorithm	4
3	Finding shortest path between any two nodes in a computer network using Prim‟s shortest path algorithm	4
4	Study of network troubleshooting using Ping and Traceroute commands	4
5	Study of various networking and inter – networking devices	4
6	Implementation of CRC generator and checker algorithm in C / C++ / Java	4
7	Implementation of Hamming code algorithm in C / C++ / Java	4
8	Study of client – server programming using sockets in a UNIX / Linux and Windows environment	4
9	Implementing client – server program using TCP / UDP sockets	4
10	Implementation of Stop – and – Wait protocol in C / C++ / Java in a client – server environment using sockets	4
11	Implementation of Sliding Window protocol in C / C++ / Java in a client – server environment using sockets	4

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12	Implementation of encryption algorithm converting plain text to cipher text using C / C++ / Java	**4**
13	Design and implement Traffic Shaping Algorithms: a. Leaky Bucket b. Token Bucket	**4**
14	Implementation of chat system	**4**
15	Allocation of Mini projects	**4**
Total Lab hours		**56**

Suggested Books/Resources:

1. James F. Kurose, Keith W. Ross, "Computer Networking: A Top-Down Approach Featuring the Internet" 3rd Edition Pearson Education
2. Andrew S. Tanenbaum, "Computer Networks" 4th Edition PHI
3. UNIX Network Programming, Volume 1, Second Edition: Networking APIs: Sockets and XTI, Prentice Hall, 1998, ISBN 0-13-490012-X.
4. Arnold Robbins, "UNIX in a Nutshell", O"Reilly 4th Edition
5. David I. Schawartz, "Introduction to UNIX", Prentice Hall, Second Edition
6. BEHROUZ a. Forouzan and Richard F. Gilberg, "UNIX and Shell Programming: A Textbook"
7. NS Simulator for Beginner"s, Lecture notes Univ. de Los Andes, France.
8. Link to topics related to course:
   i. https://www.coursera.org/specializations/networking-basics
   ii. https://nptel.ac.in/courses/106105080/
   iii. https://swayam.gov.in/course/4066-computer-networks

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Attendance	15 Marks
4	Lab Assessment	45 Marks
	Total	100 marks

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Average
CO-1	3	3	3	3	3	1	1	3	3	3	1	3	**2.5**
CO-2	2	2	2	2	2	1	1	1	2		1	2	**1.6**
CO-3	3	3	3	3	3	1	1	1	3	1	1	3	**2.2**
CO-4	2	2	2	2	2	2	1	1	2		2	2	**1.8**
CO-5	2	2	2	2	2	3	1	1	2	2	2	2	**1.9**
CO-6	2	2	2	2	2	2	1	2	2	2	2	2	**1.9**
CO-7	2	2	2	2	2	2	1	2	2	2	2	2	**1.9**
Average	**2.3**	**2.3**	**2.3**	**2.3**	**2.3**	**1.7**	**1**	**1.6**	**2.3**	**2**	**1.6**	**2.3**	

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Communication Engineering

COURSE CODE: 18B1WEC535

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Signals & Systems, Basic Course in Probability.

Course Objectives:

1. To understand the use of communication in the field of satellites and the concept of spread spectrum.
2. To make the students familiar with the implications of laws of information theory and coding with reference to the application in communication engineering.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Students will be familiar with the various fields/trends of communications like Satellite communication, Information theory and coding, and spread spectrum technique related to radio and telecommunication.	Familiarity
CO-2	To analyze the error performance of digital modulation systems in the presence of noise.	Assessment
CO-3	Design link power budget for satellite communication.	Assessment
CO-4	Design the channel based on given constraint using information theory.	Assessment
CO-5	Apply various codes like linear block codes, convolution codes etc. for channel performance analysis.	Usage
CO-6	Analyze the performance of spread spectrum systems in jamming environment.	Assessment

Course Contents:

Unit	Contents	Lectures required
1	Introduction to Baseband Transmission and Pass band Digital Modulation: Matched Filter, Inter Symbol Interference, Eye Pattern, Overview of ASK, FSK, PSK, and QAM, Basics of MSK, Signal Constellations, Probability of error analysis of modulation schemes.	6
2	Communication Link Analysis: The Channel, Error-Performance Degradation, Sources of Signal Loss and Noise, Received Signal Power and Noise Power, Link Budget Analysis, Noise Figure, Noise Temperature, System temperature, Sample Link Analysis.	9
3	Fundamental Limits in Information Theory: Uncertainty, Information, Entropy, Source-Coding Theorem, Data Compaction, Discrete Memoryless Channels, Mutual Information, Channel Capacity, Channel-Coding Theorem.	9
4	Error-Control Coding: Introduction, Linear Block Codes, Syndrome, Syndrome Decoding, Cyclic Codes, Generator Polynomial, Parity-Check Polynomial, Convolution Codes, Code tree, Trellis Diagram, Maximum Likelihood Decoding of Convolution Codes, Viterbi Algorithm.	10
5	Spread-Spectrum Modulation: Introduction, Pseudo-Noise Sequences, Direct Sequence Spread Spectrum with coherent BPSK, Signal-Space Dimensionality and Processing Gain, Frequency Hopping Spread Spectrum.	8
Total lectures		42

Suggested Text Book(s):

1. Simon Haykin, "Communication Systems", 4th Ed., John Wiley & Sons, 2004.
2. Bernard Sklar and P. K. Ray, "Digital Communications: Fundamentals and Applications", 2nd Ed., Pearson Education, 2012.

Suggested Reference Book(s):

1. B. P. Lathi and Zhi Ding, "Modern Digital and Analog Communication Systems", 4th Ed., Oxford, 2010.

Other useful resource(s):

Link to NPTEL course contents: https://nptel.ac.in/courses/117105131/16
Link to NPTEL course contents: https://nptel.ac.in/courses/117101053/1
Link to NPTEL course contents: https://nptel.ac.in/courses/117105136/1

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (1) - 5 Quizzes (2) - 15 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course Outcomes (Communication Engineering)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	3	3	1	2	1	2	1	2	2	3	2.17
CO-2	3	3	3	3	3	2	2	2	1	1	1	3	2.25
CO-3	3	3	3	3	2	3	3	2	1	2	3	3	2.58
CO-4	3	3	3	2	2	1	1	1	1	2	3	3	2.08
CO-5	3	3	3	2	3	2	1	2	1	2	3	3	2.33
CO-6	3	3	2	2	2	3	3	2	2	3	3	3	2.58
Average	3.00	3.00	2.83	2.50	2.17	2.17	1.83	1.83	1.17	2.00	2.50	3.00	

CONTEMPORARY INDIA IN GLOBALIZED ERA: CHALLENGES OF DEMOCRACY AND DEVELOPMENT

COURSE CODE: 18B1WHS831

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

1. The course introduces students to contemporary India with special focus on challenges of democracy and development and main vectors that are moulding India's course in today's globalised era.
2. The course begins with an overview of India's emergence from colonial trappings and its progression in past decades to acclaim a global stature in world affairs.
3. The course deliberates on major issues of Indian foreign policy, especially the problematic of peace and security in the globalised world.
4. The overall aim of the course is to develop a broad and yet nuanced understanding of prospects and challenges of contemporary India in the twenty-first century.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	The course introduces students to contemporary India with special focus on challenges of democracy and development and main vectors that are moulding India's course in today's globalised era.	Familiarity
CO-2	The course begins with an overview of India's emergence from colonial trappings and its progression in past decades to acclaim a global stature in world affairs.	Familiarity
CO-3	The course deliberates on major issues of Indian foreign policy, especially the problematic of peace and security in the globalised world.	Familiarity
CO-4	The overall aim of the course is to develop a broad and yet nuanced understanding of prospects and challenges of contemporary India in the twenty-first century.	Familiarity

Course Contents:

Unit	Contents	Lectures required
1	**Contextualising Modern India:** Overarching visions of India's national movement: domestic and international, Challenges of nation-building within its domestic contours, Continuities and shifts in Indian polity and society, Rising aspirations and constraints in post Globalized era, Digitising India: Prospects and Challenges	10
2	**India in World Affairs:**Gandhi-Nehru Legacy and policy of nonalignment: Formative Years, Post-Cold war challenges and changing global configurations, India's growing role in world affairs: soft power capacity, diaspora, major bilateral,	15

	regional and global concerns and aspirations, India and Major Powers, India and its neighbours, India and Brics	
3	**India's security concerns:** External Threats: China and Pakistan,Internal Threats: Kashmir and Northeast, Spectre of Terrorism	**9**
4	**Non-traditional Security:** Human Security Concerns, Energy Security, Water and Food Security, Health and Safety	**6**
5	**Challenges ahead:** India has had a phenomenal rise in terms of economic growth, technical knowhow, and has performed well on various other parameters. Nonetheless there are severe constraints to its unfolding. This topic will cover some of the challenges that India is facing today and the measures it is taking to overcome them.	**2**
Total lectures		**42**

Suggested Text Book(s):

1. Tharoor, Shashi. 'India: From Midnight to the Millennium'
2. Wajid Ali, H.M. 'India and the Non-aligned Movement'
3. Budhania, Rajpal. 'India's National Security Dilemma'
4. Asthana, Vandana. Shukla, A.C. 'Water Security in India'

Suggested Reference Book(s):

1. Candra Bipin, ‘Freedom Struggle’
2. Ram Chandra Guha, ‘India after Gandhi’
3. Tharoor, Shashi. 'India: From Midnight to the Millennium'
4. Chandra, Bipan. 'India since Independence'
5. Sen, Amartya. 'Development as Freedom’
6. Ninan Thomas,Pradeep. 'Digital India: Understanding Information, Communication and Social Change'
7. Menon, Shivshankar. 'Choices: Inside the Making of Indian Foreign Policy'
8. Wajid Ali, H.M. 'India and the Non-aligned Movement'
9. Mandrup, Thomas. 'The BRICS and Coexistance'
10. Sikri, Rajiv. 'Challenge and Strategies: Rethinking India's Foreign Policy'
11. P. Bajpai, Kanti. Pant, Harsh.V. 'India's National Security'.
12. Budhania, Rajpal. 'India's National Security Dilemma'
13. Sondhi. M.L. 'Nuclear Weapons and India's National Security'
14. Centre for Strategic Studies - 'Energy Security Challenges: Non Traditional Security Planning in India'
15. Asthana, Vandana. Shukla, A.C. 'Water Security in India'
16. Kolas, Ashild and Miklian, Jason. 'India's Human Security: Lost Debates, Forgotten
17. People, Intractable Challenges’.
18. Venkateshwar, Sita. 'Globalisation and the Challenges of Development in Contemporary India'

Other useful resource(s):

1. https://www.goodreads.com/book/show/356824.India_After_Gandhi
2. https://www.springer.com/in/book/9789811004537
3. https://www.academia.edu/35220477/NonAligned_Movement_A_Historic_Movement_reinventing_itself_for_Future_NonAligned_Movement_A_Historic_Movement_reinvening_itself_for_Future
4. https://www.routledge.com/Indias-Human-Security-Lost-Debates-Forgotten-People-Intractable-Challenges/Miklian Kolas/p/book/9780415830683

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1

2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (5) - 10 Report writing (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Contemporary India in Globalized era: Challenges of Democracy and development)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	0	0	3	2	2	3	3	3	3	3	0	3	2.7
CO-2	0	3	0	2	2	3	3	3	2	3	0	3	2.6
CO-3	0	2	0	2	3	3	3	3	2	3	0	3	2.6
CO-4	0	0	0	2	2	3	3	3	2	3	0	3	2.6
Average	0	2.5	3	2	2.2	3	3	3	2.2	3	0	3	

complete cost estimate and construction schedule. There will be one midterm evaluation, a presentation at the end followed by a viva-voce examination

SYLLABUS FOR ELECTIVE COURSES

Leadership and Human Resource Management: Overview of project management, TEAM, essential concepts of leadership and management, building leadership skills, leadership characteristics, leadership theories, leaders & managers, winning strategies for the construction industry, constructive communication, human motivation, integrating motives and emotions into a holistic pattern of leadership, personal orientation motive in leadership, place orientation and leadership, time orientation and leadership, organization strategy, crisis management, case studies

International Construction Business Management: Introduction, preparation for entry into international construction, international trade and the nature of international construction, international construction finance; key factors in operating and sustaining a business, business development and project management in international markets, impact of social, cultural, legal and financial aspects of international contracting, logistics of labor, materials, and equipment in a foreign environment, models of human resource management applied to international construction, the global market and competitive advantage, case studies- international consultant & contract, special problems

Value Engineering: Introduction, concept of cost & value, objectives, fundamentals and principles, methodology, techniques and applications of value engineering, project scope and budget, cost control, cost models, function analysis, life cycle costing, integrating value engineering in planning, design and construction, case studies

Construction Methods Improvement: Methods analysis, work analysis, work methods improvement, productivity analysis, measuring productivity, time study, standard data systems, predetermined time systems, work sampling, physiological work measurement, labour reporting, improving productivity, introduction to ergonomics, incentives to increase productivity, alternative methods for increasing productivity, case studies

Construction Information Systems: Management information systems in construction industry,current integration of computer aided design (CAD), computerized project management systems, use of automated programs for planning, scheduling, estimating and controlling construction projects, data processing and applications in pricing, tendering, scheduling and cost control system, simulation of construction operations,internet technology, web applications in construction, use of project planner software

Advances in Construction Materials: Newer and improved materials of construction, steel having greater ductility, tensile strength and corrosion resistance, high performance concrete, self-compacting concrete, chemicals, epoxies, latexes and bonding agents for repairs, geotextiles and geomembranes

Facilities Management : Introduction and overview of facility management, long range and annual facility planning, financial forecasting budgeting and appropriations; real estate considerations, analysis and planning; interiors and space planning; construction and renovation; types of maintenance programs, maintenance technologies, commissioning existing buildings, metering for operations and maintenance, O&M for major equipment types, operational efficiency, computerized maintenance management system, administrative services and technology

Cryptography and Network Security

COURSE CODE: 18B1WCI734

COURSE CREDIT: 2

CORE/ELECTIVE: ELECTIVE

L-T-P: 2-0-0

Pre-requisites: Introduction to Computers, Knowledge of Computer Networks

Course Objectives:

1. To understand basics of Cryptography and Network Security.
2. To know about various encryption techniques.
3. To be able to secure a message over insecure channel by various means.
4. To learn about how to maintain the Confidentiality, Integrity and Availability of a data.
5. To understand various protocols for network security to protect against the threats in the networks.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Understand the basic security services e.g.Authentication, Access Control, Confidentiality, Integrity, and Non repudiation).	Familiarity
CO-2	Learn standard symmetric encryption algorithms	Assessment
CO-3	Learn the architecture for public and private key cryptography and how public key infrastructure (PKI) supports network security.	Assessment
CO-4	Learn the methods of digital signature and encryption.	Assessment
CO-5	Learn key management and how key exchange protocols work.	Usage
CO-6	Learn futuristic cryptographic techniques like Eliptic Curve and quantum cryptography.	Assessment

Course Contents:

Unit	Contents	Lectures required
1	**Block Symmetric Ciphers** Foundation of Security & Cryptography: OSI security architecture, Security Policy, Classical encryption techniques(Substitution Techniques, Transposition Techniques and Staganography) **Mathematical Tools for Cryptography:** Finite fields, number theory,Design Principle of Block Ciphers:DES, Block Cipher Algorithms: AES,Pseudo Random Numbers & Stream Ciphers: Multiple Encryption, Block Cipher modes of operation,stream ciphers, Confidentiality	**2** **6**
2	**Assyymmetric Ciphers** Public Key Cryptography: RSA, Key management,Hashes & Message Digest:Authentication functions,Message authentication codes,Hash functions and their security,Digital Signature, Certificates & standards,Authentication:X.509 Authentication service,	**10**
3	**Security Applications and Protocols** Electronic Mail Security:S/MIME, IP and Web Security	**5**

	Protocols:IPsec, Secure socket layer and transport layer security, secure e-transaction.	
4	**System Security** System Security : Computer Virus, Firewall & Intrusion Detection , Trusted systems, Security Investigation/Audit, Cyber Laws: IT ACT 2000, IT amendment ACT 2008..	**5**
Total lectures		**28**

Suggested Text books:

1. "Cryptography & Network Security" by Stallings, William (Seventh Edition or later).

Other useful resources:

1. Virtual Labs: http://cse29-iiith.virtual-labs.ac.in/index.php?section=Experiments Students are advised to practice virtual lab experiments at above link as and when the topics are covered in the class.

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the ProgrammeOutcomes(POs)

Course outcomes (Cryptography and Network Security)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	2	1	3	2	2	1	1	1	1	1	1	**1.6**
CO-2	3	2	1	2	2	3	1	3	3	1	2	3	**2.2**
CO-3	2	2	3	1	2	2	3	2	2	3	2	1	**2.1**
CO-4	2	3	3	3	2	3	2	3	2	1	2	1	**2.3**
CO-5	3	2	3	1	2	3	3	2	3	1	2	3	**2.3**
CO-6	3	2	1	1	2	2	2	3	2	1	1	1	**1.8**
Average	**2.7**	**2.2**	**2**	**1.8**	**2**	**2.5**	**2**	**2.3**	**2.2**	**1.3**	**1.7**	**1.7**	

Advanced Algorithms

COURSE CODE: 18B1WCI743

COURSE CREDIT: 2

CORE/ELECTIVE: ELECTIVE

L-T-P: 2-0-0

Pre-requisites: Analysis of Data Structures and Algorithms (this pre-requisite will not be waived). You are also expected to have the mathematical maturity to write formal proofs and algorithms.

Course Objectives:

1. Learn to analyze algorithms for Time and Space Complexity
2. Learn asymptotic notations for performance analysis of algorithms.
3. Learn various computing algorithms and data structure used in solving complex problems.
4. Apply important algorithmic design paradigms and method of analysis.
5. Synthesize efficient algorithm design in common engineering design situations.

Course outcomes:

S.No.	Course outcomes	Level of Attainment
CO-1	Analyze the asymptotic performance of algorithms.	Familiarity
CO-2	Write rigorous correction proof s of algorithms.	Assessment
CO-3	Demonstrate a familiarity with major algorithms and data structure.	Assessment
CO-4	Apply important algorithmic design paradigms and method of analysis.	Usage

Course Contents:

Unit	Contents	Lectures required
1	**Review of Analysis Techniques:** Growth of Functions: Asymptotic notations; Standard notations and common functions; Recurrences and Solution of Recurrence equations- The substitution method, The recurrence – tree method, The master method; Amortized Analysis: Aggregate,Accounting and Potential Methods.	8
2	**Graph Algorithms:** Bellman - Ford Algorithm; Single source shortest paths in a DAG; Johnson's Algorithm for sparse graphs; Flow networks and Ford-Fulkerson method; Maximum bipartite matching.	8
3	**Polynomials and the FFT:** Representation of polynomials;The DFT and FFT; Efficient implementation of FFT.	6
4	**Number -Theoretic Algorithms:** Elementary notions; GCD; Modular Arithmetic; Solving modular linear equations; The Chinese remainder theorem; Powers of an element; RSA cryptosystem; Primality testing; Integer factorization	6
5	**String-Matching Algorithms:** Naïve string Matching; Rabin - Karp algorithm; String matching with finite automata; Knuth-Morris-Pratt algorithm; Boyer – Moore algorithms.	8

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6	**Probabilistic and Randomized Algorithms:** Probabilistic algorithms; Randomizing deterministic algorithms, Monte Carlo and Las Vegas algorithms; Probabilistic numeric algorithms.	6
Total lectures		**42**

Suggested Text Book(s):

1. T. H Cormen, C E Leiserson, R L Rivest and C Stein: Introduction to Algorithms, 3rd Edition, Prentice-Hall of India, 2010.
2. Kenneth A. Berman, Jerome L. Paul: Algorithms, Cengage Learning, 2002.
3. Ellis Horowitz, Sartaj Sahni, S.Rajasekharan: Fundamentals of Computer Algorithms, 2nd Edition, Universities press, 2007

Suggested Reference Book(s):

1. S. Muthukrishnan, "Data streams: Algorithms and applications", Foundations and Trends in Theoretical Computer Science, Volume 1, issue 2, 2005.
2. Bach, E., and J. Shallit. Algorithmic Number Theory. Vol. 1. Cambridge, MA: MIT Press, August 26, 1996. ISBN: 9780262024051.

Other useful resource(s):

1. Link to NPTEL course contents: https://nptel.ac.in/courses/106104019/
2. Link to topics related to course:
   a. https://nptel.ac.in/courses/106104019/1
   b. https://nptel.ac.in/courses/106104019/4
   c. https://nptel.ac.in/courses/106104019/26
   d. https://nptel.ac.in/courses/106104019/27

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Advanced Algorithms)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	**1.8**
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	**2**
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	**1.8**
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	**2.1**
Average	**2**	**2.5**	**2.5**	**2.5**	**2.5**	**1**	**1**	**1**	**2**	**2.3**	**1.5**	**2**	

R Programming

COURSE CODE: 18B1WCI741

COURSE CREDIT: 2

CORE/ELECTIVE: ELECTIVE

L-T-P: 2-0-0

Pre-requisites: Basic Programming Language Knowledge, Flow Charts

Course Objectives:

R is open source free software that can handle mathematical and statistical manipulations. R Programming has its own programming language constructs like other languages as well as built in functions to perform any specialized task. This course will cover the concept how to program in R and how to use R for effective data analysis. The students will be able to understand how to install and configure R and how it could be used for an analytics programming environment and gain basic analytic skills via this high-level analytical language. **Upon completion of this course students should be able to:**

1. Introduction and Usages of R Programming
2. How to install R Software and How to use the packages in R Software
3. How to do data management for different applications using R Software
4. Able to draw the Graphs and Plots for better visualization of real life problems.
5. Able to know how the different real applications could be converted according to R Programming Environment for better data analysis.

Course Outcomes:

S. No.	Course outcomes	Level of Attainment
CO-1	To identify the usages of available R packages and associated Open Source software to meet different scientific objectives	Familiarity
CO-2	To understand how to programming in R, reading data into R, accessing R packages,	Assessment
CO-3	Able to write R functions, debugging, profiling R code, and organizing and commenting R code.	Assessment
CO-4	To design and write efficient programs using R to perform routine and specialized data manipulation/management and analysis tasks	Assessment
CO-5	To do data analysis using R for real life applications.	Assessment

Course Contents:

Unit	Contents	Lectures required
1	Introduction and History of R Programming, Basic fundamentals, installation and use of software, data editing, use of R as a calculator, functions and assignments.	4
2	Use of R as a calculator application, functions and matrix operations in R, missing data and logical operators. Conditional executions and loops in R, data management with sequences.	6
3	Data management with repeats, sorting, ordering, and lists Vector indexing, factors, Data management with strings, display and formatting.	6
4	Data management with display paste, split, find and replacement, manipulations with alphabets, evaluation of strings, data frames.	6
5	Data frames, import of external data in various file formats, statistical functions, compilation of data.	4
6	Graphics and plots, statistical functions for central tendency, variation, skewness and kurtosis, handling of bivarite data through graphics, correlations, programming and illustration with examples.	6
7	A Mini Project for Implementation of a Application in R Programming	
Total lectures		**32**

Suggested Text Book(s):

1. Hands-On Programming with R, by Garrett Grolemund, Shroff/O'Reilly; First Edition (2014)
2. Beginning R: The Statistical Programming Language, by Mark Gardener, Wiley (2013)

Suggested Reference Book(s):

1. Benjamin M. Bolker. Ecological Models and Data in R. Princeton University Press, 2008. ISBN 978-0-691-12522-0.
2. Peter Dalgaard. Introductory Statistics with R. Springer, 2nd edition, 2008. ISBN 978-0-387-79053-4.
3. Brian Everitt and Torsten Hothorn. A Handbook of Statistical Analyses Using R. Chapman & Hall/CRC, Boca Raton, FL, 2006. ISBN 1-584-88539-4.
4. John Maindonald and John Braun. Data Analysis and Graphics Using R. Cambridge University Press, Cambridge, 2nd edition, 2007. ISBN 978-0-521-86116-8.
5. Paul Murrell. R Graphics. Chapman & Hall/CRC, Boca Raton, FL, 2005. ISBN 1-584-88486-X.
6. Phil Spector. Data Manipulation with R. Springer, New York, 2008. ISBN 978-0-387-74730-9.
7. W. N. Venables and B. D. Ripley. Modern Applied Statistics with S. Springer, New York, fourth edition edition, 2002.
8. Alain Zuur, Elena N. Ieno, Neil Walker, Anatoly A. Saveiliev, and Graham M. Smith. Mixed Effects Models and Extensions in Ecology with R. Springer, New York, 2009. ISBN 978-0-387-87457-9.
9. Alain F. Zuur, Elena N. Ieno, and Erik Meesters. A Beginner's Guide to R. Use R. Springer, 2009. ISBN: 978-0-387-93836-3.

Other useful resource(s):

1. Link to NPTEL course contents:
   a. https://onlinecourses.nptel.ac.in/noc17_ma17/preview
2. Link to topics related to course:
   a. https://www.coursera.org/learn/r-programming
   b. https://www.edx.org/course/data-science-r-basics
   c. https://www.edx.org/learn/r-programming

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (R Programming)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	1	1	2	1	2	2	2	2	1	1	2	**1.6**
CO-2	3	3	3	3	3	2	2	2	2	1	1	3	**2.3**
CO-3	3	3	3	3	2	2	1	2	3	2	3	3	**2.5**
CO-4	3	3	3	3	2	2	1	2	3	2	3	3	**2.5**
CO-5	3	3	3	3	3	2	2	2	2	1	2	3	**2.4**
Average	**2.8**	**2.6**	**2.6**	**2.8**	**2.2**	**2**	**1.6**	**2**	**2.4**	**1.4**	**2**	**2.8**	

Artificial Intelligence

COURSE CODE: 18B1WCI742

COURSE CREDITS: 2

CORE/ELECTIVE: ELECTIVE

L-T-P: 2-0-0

Pre-requisites: Data Structure, Discrete Structure

Course Objectives:

1. Describe introductory techniques in Artificial Intelligence
2. Heuristic search and adversarial search, Logic for knowledge representation and reasoning
3. Reasoning under uncertainty
4. Machine Learning
5. Apply introductory techniques in Artificial Intelligence to solve realistic problems.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Determine the characteristics of a given problem that an intelligent system must solve.	Familiarity
CO-2	Apply Bayes rule to determine the probability of a hypothesis given evidence.	Assessment
CO-3	Identify examples of knowledge representations for reasoning under uncertainty.	Assessment
CO-4	List the differences among the three main styles of learning: supervised, reinforcement, and unsupervised.	Assessment
CO-5	Identify examples of classification tasks, including the available input features and output to be predicted.	Assessment

Course Contents:

Unit	Contents	Lectures Required
1	**Introduction:** Intelligence, Definitions of Intelligent Agents **Single-Agent Search:** Breadth-first, Depth-first and Iterative Deepening Search, Heuristic Search (A* search), Stochastic Local Search (Simulated Annealing, Genetic algorithms)	7
2	**Adversarial Search:** Minimax Search, Alpha-beta pruning, Stochastic Games and Expectiminimax **Knowledge Representation and Logic:** Propositional Logic, Propositional Inference , First-Order Logic, Propositional Inference (Forward chaining, Backward chaining)	7
3	**Reasoning Under Uncertainty:** Probability Bayes Rule , Bayesian Networks, Bayesian Inference	7
4	**Machine Learning**: Definition and examples of broad variety of machine learning tasks, including classification, Inductive learning, Simple statistical-based learning, such as Naive Bayesian Classifier, decision trees, The over-fitting problem, Measuring classifier accuracy	11
Total lectures		**32**

Suggested Text Book(s):

1. Artificial Intelligence a Modern Approach, 3rd Edition. Prentice Hal
2. Artificial Intelligence Hardcover by Elaine Rich and Kevin Knight

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Suggested Reference Book(s):

1. Paradigms of Artificial Intelligence Programming: Case Studies in Common Lisp by Peter Norvig
2. Machine Learning by Tom M. Mitchell
3. Prediction Machines: The Simple Economics of Artificial Intelligence by Ajay Agrawal , Joshua Gans , Avi Goldfarb

Other useful resource(s):

1. Link to NPTEL course contents:
   - **i.** https://nptel.ac.in/courses/106105077/
   - **ii.** https://nptel.ac.in/courses/106105079/
2. Link to topics related to course:
   - **i.** https://www.ibm.com/developerworks/library/cc-beginner-guide-machine-learning-ai-cognitive/index.html
   - **ii.** https://ai.google/education/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment		Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Artificial Intelligence)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	3	1	1	2	1	2	1	2	2	2	**1.9**
CO-2	3	3	3	1	3	2	1	2	1	2	3	2	**2.2**
CO-3	3	3	3	3	2	1	2	2	2	2	3	2	**2.3**
CO-4	3	3	3	3	2	1	2	2	2	2	3	2	**2.3**
CO-5	3	3	3	3	2	1	2	2	2	2	2	2	**2.3**
Weightage	**3**	**3**	**3**	**2.2**	**2**	**1.4**	**1.6**	**2**	**1.6**	**2**	**2.6**	**2**	

Cryptography and Network Security Lab

COURSE CODE: 18B1WCI774

COURSE CREDITS: 1

CORE/ELECTIVE: ELECTIVE

L-T-P: 0-0-2

Pre-requisites: Introduction to Computers, Knowledge of Computer Networks

Course Objectives:

1. Be exposed to the different cipher techniques
2. Learn to implement the algorithms like DES, RSA, MD5, SHA-1
3. Understand the Digital Signature Standard
4. Learn to use network security tools like GnuPG, KF sensor, Net Strumbler
5. Be familiar with the intrusion detection system

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Implement the cipher techniques	Usage
CO-2	Apply the mathematical foundation required for various cryptographic algorithms	Assessment
CO-3	Develop the various security algorithms	Assessment
CO-4	Design the signature scheme by applying Digital Signature Standard.	Assessment
CO-5	Use different open source tools for network security and analysis	Usage
CO-6	Demonstrate the intrusion detection system	Assessment

List of Experiments:

S.No	Description	Hours
1	Implementation of Substitution and Transposition Techniques a) Caesar Cipher b) Playfair Cipher c) Hill Cipher d) Vignere Cipher e) Rail Fence Cipher	**3**
2	Implementation of Cryptographic Algorithms a) DES-AES b) RSA Algorithm c) Diffie-Hellman Algorithm	**3**
3	Implementation of Cryptographic Algorithms d) MD5 e) SHA-1	**2**
4	Implement the SIGNATURE SCHEME - Digital Signature Standard(DSS/DSA)	**3**
5	Providing secure data storage, secure data transmission and creating digital signatures	**2**
6	Setup a Honey Pot and Monitor the Honeypot on Network	**2**
7	Installation of toolkits and study the variety of network security options	**2**
8	Perform wireless audit on an access point or a router and decrypt WEP and WPA(Net Stumbler)	**2**

9	Develop and Demonstrate intrusion detection system	**3**
10	Implement Electronic Mail Security:S/MIME	**3**
11	Implement IPSEC	**4**
Total Lab hours		**28**

Suggested Books/Resources:

1. "Cryptography & Network Security" by Stallings, William (Seventh Edition or later) will be used as the main text book, however the inputs will be supplemented with information from elsewhere wherever the same is required.
2. Virtual Labs: http://cse29-iiith.virtual-labs.ac.in/index.php?section=Experiments Students are advised to practice virtual lab experiments at above link as and when the topics are covered in the class.

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Attendance	15 Marks
4	Lab Assessment	45 Marks
	Total	100 marks

Course Outcomes (COs) contribution to the ProgrammeOutcomes(POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Average
CO1	3	2	1	3	2	2	1	1	1	1	1	1	**1.6**
CO2	3	2	1	2	2	3	1	3	3	1	2	3	**2.2**
CO3	2	2	3	1	2	2	3	2	2	3	2	1	**2.1**
CO4	2	3	3	3	2	3	2	3	2	1	2	1	**2.3**
CO5	3	2	3	1	2	3	3	2	3	1	2	3	**2.3**
C06	2	2	2	1	2	2	2	3	2	1	1	1	**1.8**
Average	**2.5**	**2.2**	**2.2**	**1.8**	**2**	**2.5**	**2**	**2.3**	**2.2**	**1.3**	**1.7**	**1.7**	

Advanced Algorithms Lab

COURSE CODE: 18B1WCI773

COURSE CREDITS: 1

CORE/ELECTIVE: ELECTIVE

L-T-P: 0-0-2

Pre-requisites: None

Course Objectives:

1. Learn to analyze algorithms for Time and Space Complexity
2. Learn asymptotic notations for performance analysis of algorithms.
3. Learn various computing algorithms and data structure used in solving complex problems.
4. Apply important algorithmic design paradigms and method of analysis.
5. Synthesize efficient algorithm design in common engineering design situations.
6. Design Bellman-Ford algorithm and determine its performance.
7. Design a Miller Rabin algorithm and Monte Carlo algorithm to test the primality of a given integer and determine its performance.
8. Design a string matching problems.

Course outcomes:

S.NO	Course outcomes	Level of Attainment
CO-1	Analyze the asymptotic performance of algorithms.	Familiarity
CO-2	Write rigorous correction proof s of algorithms.	Assessment
CO-3	Demonstrate a familiarity with major algorithms and data structure.	Assessment
CO-4	Apply important algorithmic design paradigms and method of analysis.	Usage

List of Experiments:

S.No	Description	Hours
1	Design, develop a program to implement the Bellman-Ford algorithm and determine its performance.	**4**
2	Design, develop a program to implement a Miller Rabin algorithm to test the primality of a given integer and determine its performance.	**4**
3	Design, develop a program to implement a Monte Carlo algorithm to test the primality of a given integer and determine its performance.	**4**
4	Design, develop a program to solve the string matching problem using naïve approach and the KMP algorithm and compare their performances.	**4**
5	Design, develop a program to solve string matching problem using Finite Automata and determine its performance.	**6**
6	Design, develop and write program to solve string matching problem using Robin Karp algorithm and determine its performance.	**6**
Total Lab hours		**28**

Suggested Books/Resources:

1. T. H Cormen, C E Leiserson, R L Rivest and C Stein: Introduction to Algorithms, 3rd
2. Edition, Prentice-Hall of India, 2010.
3. Kenneth A. Berman, Jerome L. Paul: Algorithms, Cengage Learning, 2002.
4. Ellis Horowitz, Sartaj Sahni, S.Rajasekharan: Fundamentals of Computer Algorithms, 2nd

5. Edition, Universities press, 2007
6. S. Muthukrishnan, "Data streams: Algorithms and applications", Foundations and Trends in Theoretical Computer Science, Volume 1, issue 2, 2005.
7. Bach, E., and J. Shallit. Algorithmic Number Theory. Vol. 1. Cambridge, MA: MIT Press, August 26, 1996. ISBN: 9780262024051.
8. Link to topics related to course:
   i. https://tejaswinihbhat.blogspot.com/2016/07/program-1-bellman-ford-algorithm-design.html
   ii. https://www.sanfoundry.com/c-program-implement-rabin-miller-primality-test-check-number-prime/
   iii. https://www.cs.bu.edu/fac/lnd/toc/z/node21.html
   iv. http://cs.indstate.edu/~kmandumula/abstract.pdf

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Attendance	15 Marks
4	Lab Assessment	45 Marks
	Total	100 marks

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	**1.8**
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	**2**
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	**1.8**
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	**2.1**
Average	**2**	**2.5**	**2.5**	**2.5**	**2.5**	**1**	**1**	**1**	**2**	**2.3**	**1.5**	**2**	

R Programming Lab

COURSE CODE: 18B1WCI771

COURSE CREDITS: 1

CORE/ELECTIVE: ELECTIVE

L-T-P: 0-0-2

Pre-requisites: None

Course Objectives:

1. Understand the Usages of R Programming, Installation of R, Configure and Execute Program.
2. Use of different packages in R Software for different problems
3. Usages of Functions and Classes in R Software
4. Able to draw the Graphs and Plots for better visualization of real life problems using plot methods.
5. Able to understand how the R Programming could be used for different case studies.

Course Outcome (CO)

S.No.	Course outcomes	Level of Attainment
CO-1	To identify the usages of methods and classes in R to meet different scientific objectives	Familiarity
CO-2	To identify the usages of plot functions in R to represent data in better form	Familiarity
CO-3	Usage of R packages, How to download new packages and use them in R.	Computational skills
CO-4	To do data analysis tasks on sample data set using R Programming.	Technical skills
CO-5	To do data analysis and exploration using R for real life applications. How it could be used further in research and analysis on datasets.	Computational skills & Assessment

List of Experiments:

S.No	Description	Hours
1	**What is R? How to Install R :- Download, Install and Configure**	2
2	**Basics of R Programming:-** Algebra, Vectors, Matrices, Manipulation, Loops/Statements	2
3	**Data Types in R Programming:-** Data Types, Converting/Using Data Types in R Programming	2
4	**Reading in Data:-** Types of Input, How to Read In Data,	2
5	**Plotting Data:-** Dot Plots, Histograms, Box Plots, Additional Features in Plotting Data in R	2
6	**Exporting Data in R:-** Types of Output, How to Export Data	2
7	**Exporting Data in R:-** Types of Output, How to Export Data	2
8	**Functions in R Programming:-** Built In Functions in R, Custom Functions in R, Graphical Functions in R	2

9	**Functions in R Programming:-** Built In Functions in R, Custom Functions in R, Graphical Functions in R	**2**
10	**Tips for Writing Good R Code:-** General Practices, Matrix Multiplication, Packages in R, Usage of Packages in R, Help in R	**2**
11	**R Editors:-** Built In R Editors, Other Editors in R, **Measures of Central Tendency and Dispersion**	**2**
12	**Statistical analyses with R:-** A simple example of analysis of variance, Array and Strings in R, Hypothesis Testing: Testing the Significance of the Difference Between Two Means	**2**
13	**Classes and Methods in R Programming:-** Setting Classes and Methods, Different Usages of Classes and Methods, Bivariate Statistics for Nominal Data	**2**
14	Code for Sample Case Study Using Methods in R Programming, List of Most Useful Functions in R Programming, Bivariate Statistics for Ordinal Data, Bivariate Statistics for Interval/Ratio Data	**2**
Additional Exercise-	Case Study for Data Analysis Using R Programming	**---**
Total Lab hours		**28**

Suggested Books/Resources:

1. Hands-On Programming with R, by Garrett Grolemund, Shroff/O'Reilly; First Edition (2014)
2. Beginning R: The Statistical Programming Language, by Mark Gardener, Wiley (2013)
3. Peter Dalgaard. Introductory Statistics with R. Springer, 2nd edition, 2008. ISBN 978-0-387-79053-4.
4. John Maindonald and John Braun. Data Analysis and Graphics Using R. Cambridge University Press, Cambridge, 2nd edition, 2007. ISBN 978-0-521-86116-8.
5. Alain F. Zuur, Elena N. Ieno, and Erik Meesters. A Beginner's Guide to R. Use R. Springer, 2009. ISBN: 978-0-387-93836-3.
6. Link to NPTEL course contents:
   https://onlinecourses.nptel.ac.in/noc17_ma17/preview
7. Important URLs:
   R Manuals: http://cran.r-project.org/ > Documentation > Manuals
   R Journal: http://journal.r-project.org/
   R Forum: http://www.nabble.com/R-f13819.html
   CRAN Home Page: http://cran.r-project.org/
8. Link to topics related to course:
   a. https://www.coursera.org/learn/r-programming
   b. https://www.edx.org/course/data-science-r-basics
   c. https://www.edx.org/learn/r-programming
   d. http://web.math.ku.dk/~helle/R-intro/exercises.pdf
   e. https://afit-r.github.io/basics
   f. https://www.cs.upc.edu/~robert/teaching/estadistica/rprogramming.pdf
   g. https://faculty.washington.edu/tlumley/Rcourse/R-fundamentals.pdf

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Course Outcomes (COs) contribution to the Programme Outcomes (POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Average
CO-1	3	2	2	1	2	2	3	2	1	3	2	1	**2**
CO-2	3	3	2	1	1	3	3	1	3	3	3	1	**2.3**
CO-3	3	3	2	1	2	2	2	1	2	3	3	2	**2.2**
CO-4	3	3	3	2	2	2	3	2	2	1	2	2	**2.3**
CO-5	3	3	2	2	2	2	2	2	2	3	3	3	**2.4**
Average	**3**	**2.8**	**2.2**	**1.4**	**1.8**	**2.2**	**2.6**	**1.6**	**2**	**2.6**	**2.6**	**1.8**	

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Artificial Intelligence Lab

COURSE CODE: 18B1WCI772

COURSE CREDITS: 1

CORE/ELECTIVE: ELECTIVE

L-T-P: 0-0-2

Pre-requisite: None

Course Objectives:

1. Describe introductory techniques in Artificial Intelligence
2. Heuristic search and adversarial search, Logic for knowledge representation and reasoning
3. Reasoning under uncertainty
4. Machine Learning
5. Apply introductory techniques in Artificial Intelligence to solve realistic problems.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Determine the characteristics of a given problem that an intelligent system must solve.	Familiarity
CO-2	Apply Bayes' rule to determine the probability of a hypothesis given evidence.	Assessment
CO-3	Identify examples of knowledge representations for reasoning under uncertainty.	Assessment
CO-4	List the differences among the three main styles of learning: supervised, reinforcement, and unsupervised.	Assessment
CO-5	Identify examples of classification tasks, including the available input features and output to be predicted.	Assessment

List of Experiments:

S.No	Description	Hours
1	Implementation of DFS and BFS Searching Algorithms	**2**
2	Implementation of A* Algorithm	**2**
3	Study of Prolog Language	**2**
4	Write simple fact for the statements using PROLOG.	**2**
5	Write predicates One converts centigrade temperatures to Fahrenheit, the other checks if a temperature is below freezing	**2**
6	WAP in turbo prolog for medical diagnosis and show that advantage and disadvantage of green and red cuts.	**2**
7	Write a program to solve the Monkey Banana problem	**2**
8	Study of LISP Language	**2**
9	Write a program to solve water jug problem using LISP	**2**
10	Consider House-votes dataset provided in lab. The task is to predict whether the voter is a republican or a democrat based on their votes using Naive Bayes algorithm with 5-fold cross validation. It has 16 binary attributes and 2 classes.	**2**
11	In Experiment 10, Estimate the accuracy of Naive Bayes algorithm using 5-fold cross validation on the house-votes data set.	**2**

Approved in Academic Council held on 25.10.2018

<table>
<tr><td>12</td><td>In Experiment 10, Estimate the precision, recall, accuracy, and F-measure using 10-fold cross-validation.</td><td>2</td></tr>
<tr><td>13</td><td>Consider Breast Cancer data set provided in class. It has 9 numeric attributes and 2 types of cancer to be predicted. Compare the performance of 10 machine learning models for given classification data set for the data partition of 70-30%.
<table>
<tr><th>Model</th><th>Sensitivity</th><th>Specificity</th><th>Precision</th><th>Recall</th><th>Accuracy</th><th>F-Score</th></tr>
<tr><td>M1</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>M2</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>...</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>M10</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table></td><td>2</td></tr>
<tr><td>14</td><td>Ensemble the models from Experiment 13 for given data set on data partition of 70-30%.
<table>
<tr><th>Model</th><th>Combination</th><th>Sensitivity</th><th>Specificity</th><th>Precision</th><th>Recall</th><th>Accuracy</th></tr>
<tr><td>E1</td><td>M1, M5, M6, M7, M10</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>E2</td><td>M1, M2, M4</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>E3</td><td>M2, M4, M6, M8, M10</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>E4</td><td>M5, M7, M8</td><td></td><td></td><td></td><td></td><td></td></tr>
</table></td><td>2</td></tr>
<tr><td colspan="2">Total Lab hours</td><td>28</td></tr>
</table>

Suggested Books/Resources:

1. Paradigms of Artificial Intelligence Programming: Case Studies in Common Lisp by Peter Norvig
2. Programming in Prolog-Springer by William F. Clocksin, Christopher S. Mellish
3. Machine Learning by Tom M. Mitchell
4. Prediction Machines: The Simple Economics of Artificial Intelligence by Ajay Agrawal , Joshua Gans , Avi Goldfarb
5. Artificial Intelligence a Modern Approach, 3rd Edition. Prentice Hal
6. Artificial Intelligence Hardcover by Elaine Rich and Kevin Knight
7. Link to topics related to course:
    - **i.** https://www.ibm.com/developerworks/library/cc-beginner-guide-machine-learning-ai-cognitive/index.html
    - **ii.** https://ai.google/education/

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Attendance	15 Marks
4	Lab Assessment	45 Marks
	Total	100 marks

Approved in Academic Council held on 25.10.2018

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Average
CO-1	3	3	3	2	1	2	1	2	1	2	2	2	**2**
CO-2	3	3	3	2	3	2	1	2	1	2	3	2	**2.3**
CO-3	3	3	3	3	2	1	2	2	2	2	3	2	**2.3**
CO-4	3	3	3	3	2	1	2	2	2	2	3	2	**2.3**
CO-5	3	3	3	3	2	1	2	2	2	2	2	2	**2.3**
Average	**3**	**3**	**3**	**2.6**	**2**	**1.4**	**1.6**	**2**	**1.6**	**2**	**2.6**	**2**	

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Department of Computer Sc. & Engg. and Information Technology
Minor Program in CSE

Minor program in CSE consist the following major disciplines in which student has to complete 14 mandatory credits and 6 non-mandatory credits to complete total 20 additional credits.

Subject Code	Type	Semester	Name of the Subject(s)	Credits
18B11CI412	Mandatory	4	Design & Analysis of Algorithms	3
18B17CI472	Mandatory	4	Design and Analysis of Algorithms Lab	2
18B11CI513	Mandatory	5	Formal Language & Automata Theory	3
18B1WCI575	Mandatory	5	Multimedia Lab	1
18B11CI612	Mandatory	6	Compiler Design	3
18B17CI672	Mandatory	6	Compiler Design Lab	2
18B1WCI733	Non-Mandatory	7	Advanced Algorithms	2
18B1WCI773	Non-Mandatory	7	Advanced Algorithms Lab	1
18B1WCI740	Non-Mandatory	7	Computational Techniques and Algorithms in Engineering	3
18B1WCI834	Non-Mandatory	8	Network Management	3
18B1WCI831	Non-Mandatory	8	Data Analytics	3
			TOTAL	**14+6**

Minor program in IT

Minor program in IT consist the following major disciplines in which student has to complete 14 mandatory credits and 6 non-mandatory credits to complete total 20 additional credits.

Category Code	Type	Semester	Name of the Subjects	Credits
18B1WCI639	Mandatory	4	Software Engineering Practices	3
18B1WCI679	Mandatory	4	Software Engineering Practices Lab	2
18B11CI512	Mandatory	5	Information Systems	3
18B17CI572	Mandatory	5	Information Systems Lab	1
18B11CI613	Mandatory	6	Data Mining	3
18B17CI673	Mandatory	6	Data Mining Lab	2
	Non-Mandatory	7	Building IoT and Network Applications	2
	Non-Mandatory	7	Building IoT and Network Applications Lab	1
	Non-Mandatory	7	An Introduction to Statistical learning	3
	Non-Mandatory	8	Foundations of Blockchain	3
	Non-Mandatory	8	Fog Computing in IoT	3
			TOTAL	**14+6**

Proficiency Courses in CSE & IT Discipline

Proficiencies proposed and the elective courses relevant to each proficiency are outlined below. A student is required to take 50% of the electives in the regular curricula from the list of courses prescribed for each proficiency.

i. Proficiency in Information Security

As digital information moves to a more networked and globalized infrastructure, it is essential that one should understand the threats to this information. The creation of effective corporate- wide security plans with well established security programs, policies, controls, and procedures as well as awareness and training initiatives is getting more focus with the rising demand of Information security professionals.

Proficiency in Information security consist the following major disciplines:

Elective	Course Code	Semester	Name of the Subjects	Credits
Elective -1	18B1WCI532	5th Sem	Data Compression	2
Elective -1	18B1WCI572	5th Sem	Data Compression Lab	1
Elective -2	19B1WCI631	6th Sem	Digital Forensics	2
Elective -2	19B1WCI671	6th Sem	Digital Forensics lab	1
Elective -3	19B1WCI632	6th Sem	Information Security	2
Elective -3	19B1WCI672	6th Sem	Information Security Lab	1
Elective -4	18B1WCI734	7th Sem	Cryptography& network security	2
Elective -4	18B1WCI774	7th Sem	Cryptography& network security Lab	1
Elective -5	19B1WCI736	7th Sem	Information Auditing & Risk Management	3
Elective -6	19B1WCI831	8th Sem	Ethics and Information Technology	3

ii. Proficiency in Data Sciences

Unlike classical statistics, the need to process and manage massive amounts of data has become a key feature of modern statistics. Data Science provides a foundation for problem- solving in a data-driven society. Data Science applies core concepts in computer science, statistics and mathematics to problems in a wide variety of fields, from physical, social, biomedical, and behavioral sciences to arts and humanities. This proficiency will enable students with preliminary data collection, manipulation, access and/or analysis skills as are appropriate to data needs in their majors.

Proficiency in Data Sciences consist the following major disciplines:

Elective	Course Code	Semester	Name of the Subjects	Credits
Elective -1	20B1WCI531	5th Sem	Foundation for Data Science and Visualization	2
Elective -1	20B1WCI571	5th Sem	Data Science and Visualization Lab	1
Elective -2	18B1WCI634	6th Sem	Machine Learning	2
Elective -2	18B1WCI674	6th Sem	Machine Learning Lab	1
Elective -3	20B1WCI732	6th Sem	From Graph to Knowledge Graph	2
Elective -3	20B1WCI772	6th Sem	From Graph to Knowledge Graph Lab	1
Elective -4	19B1WCI731	7th Sem	Computational Data Analysis	2
Elective -4	19B1WCI771	7th Sem	Computational Data Analysis lab	1
Elective -5	19B1WCI737	7th Sem	Optimization Methods in Business Analytics	3
Elective -6	18B1WCI832	8th Sem	Social and Information Network Analysis	3

iii. Proficiency in Machine Learning

Rising demand of Machine learning (ML) have exploded in importance in recent years and garnered attention in a wide variety of application in diverse areas such as bioinformatics, fraud detection, intelligent systems, perception, finance, information retrieval, and other areas. This proficiency will allow undergraduates to learn about the core principles of machine learning.

Proficiency in machine learning consist the following major disciplines:

Elective	Course Code	Semester	Name of the Subjects	Credit
Elective -1	20B1WCI531	5th Sem	Foundation for Data Science and Visualization	2
Elective -1	20B1WCI571	5th Sem	Data Science and Visualization Lab	1
Elective -2	18B1WCI634	6th Sem	Machine Learning	2
Elective -2	18B1WCI674	6th Sem	Machine Learning Lab	1
Elective -3	18B1WCI635	6th Sem	Data Mining & Data Warehousing	2
Elective -3	18B1WCI675	6th Sem	Data Mining & Data Warehousing Lab	1
Elective -4	18B1WCI734	7th Sem	Cryptography& network security	2
Elective -4	18B1WCI774	7th Sem	Cryptography& network security Lab	1
Elective -5	19B1WCI736	7th Sem	Information Auditing & Risk Management	3
Elective -6	19B1WCI832	8th Sem	Probabilistic Graphical Models	3

iv. Proficiency in Computer Graphics

Computer Graphics provides an exciting and rapidly developing industry with myriad opportunities for working in film and TV, scientific and medical visualisation, computer games and the web. This proficiency will allow undergraduates to focus on producing computer-generated graphics and is particularly useful for those interested in animation, and game designing.

Proficiency in computer graphics consist the following major disciplines:

Elective	Course Code	Semester	Name of the Subjects	Credit
Elective -1	20B1WCI531	5th Sem	Foundation for Data Science and Visualization	2
Elective -1	20B1WCI571	5th Sem	Data Science and Visualization Lab	1
Elective -2	19B1WCI633	6th Sem	Computer Animation	2
Elective -2	19B1WCI673	6th Sem	Computer Animation Lab	1
Elective -3	18B1WCI636	6th Sem	Digital Image processing	2
Elective -3	18B1WCI676	6th Sem	Digital Image processing Lab	1
Elective -4	19B1WCI732	7th Sem	Game Development and Design	2
Elective -4	19B1WCI772	7th Sem	Game Development Lab	1
Elective -5	18B1WCI840	7th Sem	Computer Vision	3
Elective -6	19B1WCI833	8th Sem	Information Modeling	3

v. Proficiency in Big Data and Visual Analytics

Big Data and Business Analytics is a fast growing field with applications in business decision making, patient care, political decision making, criminal justice, IT security etc. This proficiency provides knowledge of key concepts, methods, techniques, and tools of big data and visual analytics from organization perspective to the various undergraduates.

Proficiency in big data and visual analytics consist the following major disciplines:

Elective	Course Code	Semester	Name of the Subjects	Credit
Elective -1	19B1WCI531	5th Sem	Big Data using Hadoop	2
Elective -1	19B1WCI571	5th Sem	Big Data using Hadoop Lab	1
Elective -2	18B1WCI634	6th Sem	Machine Learning	2
Elective -2	18B1WCI674	6th Sem	Machine Learning Lab	1
Elective -3	18B1WCI635	6th Sem	Data Mining & Data Warehousing	2
Elective -3	18B1WCI675	6th Sem	Data Mining & Data Warehousing Lab	1
Elective -4	19B1WCI731	7th Sem	Computational Data Analysis	2
Elective -4	19B1WCI771	7th Sem	Computational Data Analysis lab	1
Elective -5	19B1WCI738	7th Sem	Introduction to Deep Learning	3
Elective -6	19B1WCI834	8th Sem	Information Visualization	3

vi. Proficiency in Image Analysis and Processing

Recent explosive growth of digital imaging technology makes the problems of automated image interpretation more exciting and relevant than ever. Image analysis and processing is a highly interdisciplinary field of study that incorporates elements from mathematics, engineering, and computer science to understand, design, and utilize imagery and imaging systems to study scientific phenomena. This proficiency provides knowledge of modern methods of automatic processing and analysis of digital images and video, and methods of image understanding and computer vision to the various undergraduates.

Proficiency in image analysis and processing consist the following major disciplines:

Elective	Course Code	Semester	Name of the Subjects	Credit
Elective -1	19B1WCI532	5th Sem	Image Analysis and Pattern Recognition	2
Elective -1	19B1WCI572	5th Sem	Image Analysis and Pattern Recognition Lab	1
Elective -2	19B1WCI634	6th Sem	Computer and Robot Vision	2
Elective -2	19B1WCI674	6th Sem	Computer and Robot Vision lab	1
Elective -3	18B1WCI636	6th Sem	Digital Image processing	2
Elective -3	18B1WCI676	6th Sem	Digital Image processing Lab	1
Elective -4	20B1WCI731	7th Sem	Artificial Intelligence	2
Elective -4	20B1WCI771	7th Sem	Artificial Intelligence Lab	1
Elective -5	18B1WCI840	7th Sem	Computer Vision	3
Elective -6	19B1WCI834	8th Sem	Information Visualization	3

vii. Proficiency in Cloud Computing

With the wide usage of Internet and the increasing popularity of mobile computing devices (e.g. smartphones, tablets, and laptops) in society, computer users are migrating their computing usage and data storage from a single personal computing environment to a web- based, distributed and networked computing environment. This proficiency will equip undergraduates with the essential knowledge of cloud computing and various tools and technologies.

Proficiency in cloud computing consist the following major disciplines:

Elective	Course Code	Semester	Name of the Subjects	Credit
Elective -1	20B1WCI532	5th Sem	Cloud Computing: Concepts, Technology & Architecture	2
Elective -1	20B1WCI572	5th Sem	Cloud Computing: Concepts, Technology & Architecture Lab	1
Elective -2	18B1WCI634	6th Sem	Machine Learning	2
Elective -2	18B1WCI674	6th Sem	Machine Learning Lab	1
Elective -3	19B1WCI635	6th Sem	Architecting Distributed Cloud Applications	2
Elective -3	19B1WCI675	6th Sem	Architecting Distributed Cloud Applications Lab	1
Elective -4	20B1WCI731	7th Sem	Artificial Intelligence	2
Elective -4	20B1WCI771	7th Sem	Artificial Intelligence Lab	1
Elective -5	18B1WCI736	7th Sem	Storage Networks	3
Elective -6	19B1WCI835	8th Sem	Cloud Computing Security	3

viii. Proficiency in Human Computer Interaction

Human-Computer Interaction (HCI) is the study of how humans interact with technology through principled design, communication, and construction. HCI addresses the design, evaluation, and implementation of computer based systems for the benefit of human use. This proficiency provides undergraduates core knowledge about techniques for building successful user interfaces.

Proficiency in human computer interaction consist the following major disciplines:

Elective	Course Code	Semester	Name of the Subjects	Credit
Elective -1	19B1WCI533	5th Sem	Human-Computer Interaction	2
Elective -1	19B1WCI573	5th Sem	Human-Computer Interaction Lab	1
Elective -2	19B1WCI636	6th Sem	Computability, Complexity & Algorithms	2
Elective -2	19B1WCI676	6th Sem	Computability, Complexity & Algorithms Lab	1
Elective -3	18B1WCI638	6th Sem	Pattern Recognition	2
Elective -3	18B1WCI678	6th Sem	Pattern Recognition Lab	1
Elective -4	20B1WCI731	7th Sem	Artificial Intelligence	2
Elective -4	20B1WCI771	7th Sem	Artificial Intelligence Lab	1
Elective -5	18B1WCI840	7th Sem	Computer Vision	3
Elective -6	19B1WCI836	8th Sem	Knowledge-Based AI: Cognitive Systems	3

ix. Proficiency in Artificial Intelligence

With the rapid increase in data volumes, advanced algorithms, and improvements in computing power and storage have made possible for machines to learn from experience and perform human-like tasks. Artificial Intelligence has fulfilled this dream which can be applied to almost every field. This proficiency introduces students to the techniques of artificial intelligence programming and the basic theoretical concepts of artificial intelligence, knowledge representation, and automated reasoning.

Proficiency in artificial intelligence consist the following major disciplines:

Elective	Course Code	Semester	Name of the Subjects	Credit
Elective -1	20B1WCI531	5th Sem	Foundation for Data Science and Visualization	2
Elective -1	20B1WCI571	5th Sem	Data Science and Visualization Lab	1
Elective -2	18B1WCI634	6th Sem	Machine Learning	2
Elective -2	18B1WCI674	6th Sem	Machine Learning Lab	1
Elective -3	19B1WCI637	6th Sem	Statistics and Exploratory Data Analytics	2
Elective -3	19B1WCI677	6th Sem	Statistics and Exploratory Data Analytics Lab	1
Elective -4	20B1WCI731	7th Sem	Artificial Intelligence	2
Elective -4	20B1WCI771	7th Sem	Artificial Intelligence Lab	1
Elective -5	19B1WCI738	7th Sem	Introduction to Deep Learning	3
Elective -6	19B1WCI837	8th Sem	Reinforcement Learning	3

x. Proficiency in Social Computing

The collaborative exchange of ideas is essential to the success of difficult initiatives, including software architecture and design, project management and organizational transformation. Technology has made collaboration at a distance possible in new ways that present their own set of challenges. Social computing is concerned with systems of this sort and the mechanisms and principles that underlie them. This proficiency introduces undergraduates to the major challenges and opportunities for creating online communities.

Proficiency in social computing consist the following major disciplines:

Elective	Course Code	Semester	Name of the Subjects	Credit
Elective -1	19B1WCI534	5th Sem	Social Media	2
Elective -1	19B1WCI574	5th Sem	Social Media Lab (Node XL)	1
Elective -2	19B1WCI638	6th Sem	Statistics and Data Science	2
Elective -2	19B1WCI678	6th Sem	Statistics and Data Science Lab	1
Elective -3	20B1WCI732	6th Sem	From Graph to Knowledge Graph	2
Elective -3	20B1WCI772	6th Sem	From Graph to Knowledge Graph Lab	1
Elective -4	20B1WCI731	7th Sem	Artificial Intelligence	2
Elective -4	20B1WCI771	7th Sem	Artificial Intelligence Lab	1
Elective -5	18B1WCI737	7th Sem	Cloud Computing	3
Elective -6	18B1WCI832	8th Sem	Social and Information Network Analysis	3

Statistics and Data Science

COURSE CODE: XXXXXXXX COURSE CREDITS: 2 CORE/ELECTIVE: ELECTIVE L-T-P: 2-0-0
Pre-requisite: Basic knowledge of High School Mathematics and reasonable programming experience.

Course Objectives:

1. Understand the Fundamentals of Statistics
2. Understand the Probability for Data Analysis
3. Learn how to work with Different Types of Data
4. Different Types of Distributions
5. Apply Statistical Methods and Hypothesis Testing to Business Problems
6. Understand all the concepts of Statistics for Data Science and Analytics
7. Working of Regression Analysis
8. Implement one way and two way ANOVA
9. Chi-Square Analysis
10. Central Limit Theorem

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	Understand all the concepts of Statistics for Data Science and Analytics	Familiarity
CO-2	Compute the probabilities of events along with an understanding of the random variables, expectation, variance, and distributions.	Usage
CO-3	Identify probability distributions commonly used as foundations for statistical modeling.	Assessment
CO-4	Apply Statistical Methods and Hypothesis Testing to Business Problems	Usage
CO-5	Broaden the knowledge about Random Variables, Joint Distributions, Special Distributions	Assessment
CO-6	To have hands-on skills on Illustrative example for data analysis(Implementation of statistical techniques, data interpretation, Regression Analysis, Covariance, Hypothesis testing and analysis of variance)	Usage

Course Contents:

Unit	Contents	Lectures Required
1	**Introduction:** What is Data Science? - Big Data and Data Science hype – and getting past the hype - Why now? – Datafication - Current landscape of perspectives - Skill sets needed **Probability:** Classical, relative frequency, and axiomatic definitions of probability, addition rule and conditional probability, multiplication rule, total probability, Bayes' Theorem and independence, problems.	4
2	**Random Variables:** Discrete, continuous, and mixed random variables, probability mass, probability density, and cumulative distribution functions, mathematical expectation, moments, probability and moment generating function, median, and quantiles, Markov inequality, Chebyshev's inequality, problems, Function of a random variable, problems.	5
3	**Special Distributions:** Discrete uniform, binomial, geometric, negative binomial, hypergeometric, Poisson, continuous uniform, exponential, gamma, Weibull, Pareto, beta, normal, lognormal, inverse Gaussian, Cauchy, double exponential distributions, reliability and hazard rate, reliability of series and parallel systems, problems.	4
4	**Joint Distributions:** Joint, marginal and conditional distributions, product moments, correlation and regression, independence of random variables, bivariate normal distribution, problems**.**	4
5	**Sampling Distributions:** The Central Limit Theorem, distributions of the sample mean and the sample variance for a normal population, Chi-Square, t and F distributions, problems	5
6	**Testing of Hypotheses:** Null and alternative hypotheses, the critical and 8 acceptance regions, two types of error, power of the test, the most powerful test and Neyman-Pearson Fundamental Lemma, tests for one sample and two sample problems for normal populations, tests for proportions, Chisquare goodness of fit test and its applications, problems.	6
	Total Lecture Hours	**28**

Suggested Text Book(s):

- An Introduction to Probability and Statistics by V.K. Rohatgi & A.K. Md. E.Saleh, Wiley, (2008), 3rd ed.
- Introduction to Probability and Statistics by J.S. Milton & J.C. Arnold, Boston, London, McGraw-Hill, (2006), 4th ed.
- Data Science and analytics with python by Jesus Rogel-Salazar.

Suggested Reference Book(s):

- Introduction to Probability Theory and Statistical Inference by H.J. Larson, John Wiley & Sons, (2005) 3rd ed.

- Introduction to Probability and Statistics for Engineers and Scientists by S.M. Ross, Elsevier, (2014), 4th ed.
- Python Data Science Handbook by Jake VanderPlas, 2017.

Other useful resource(s):

- https://nptel.ac.in/courses/110/106/110106064/
- https://onlinecourses.nptel.ac.in/noc18_cs28/pr eview
- https://bit.ly/2GvlBfs
- https://bit.ly/3aONiOo

Evaluation Scheme:

S No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course Outcomes (Statistics and Data Science)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	1.8
CO-2	2	3	3	3	3	1	1	1	2	2	1	1	1.9
CO-3	2	2	2	2	1	1	1	1	2	2	1	2	1.6
CO-4	3	3	3	3	2	1	1	1	2	3	3	2	2.3
CO-5	2	3	3	3	1	1	1	1	2	3	2	2	2
CO-6	2	3	3	3	2	1	1	1	2	3	2	2	2.1
Average	2.2	2.7	2.7	2.7	1.8	1	1	1	2	2.5	1.8	1.8	1.9

Statistics and Data Science Lab

COURSE CODE: XXXXXXXX COURSE CREDITS: 1 CORE/ELECTIVE: ELECTIVE L-T-P: 0-0-2

Pre-requisite: Basics of programming in R or Python

Course Objectives:

1. Understand the fundamentals of statistics and apply them in practice
2. To analyze the data using different descriptive measures and present graphically.
3. Compute the probabilities of events along with an understanding of the random variables, expectation, variance and distributions.
4. Understand the estimation of mean and variance and their respective one-sample and k sample hypothesis tests.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO1	Understand basics of Python or R syntax, functions and programming	Familiarity
CO2	Learn the core tools for data science with R or Python	Usage
CO3	Understand and carry out regression analysis	Usage
CO4	Visualize data: plot different types of data & draw insights	Usage
CO5	Hypothesis testing in R or Python	Usage
CO6	Analyze the systems using Laplace transform and Z-transform.	Usage

List of Experiments

S. No.	Description	Hours
1	Introduction to the basics of Python or R syntax, functions, and programming.	**2**
2	Introduction various packages are available for statistical analysis. (e.g. “stats” package in R, Lib/statistics.py package in python)	**2**
3	Implementation of statistical techniques using statistical packages.	**2**
4	Evaluation of Statistical Parameters and data interpretation	**2**
5	Regression Analysis	**2**
6	Covariance Analysis	**2**
7	Hypothesis testing	**2**
8	Analysis of variance	**2**
9	Introduction to Numpy in Python	**2**
10	Data Manipulation with Pandas	**2**
11	Data Visualization with Matplotlib	**2**
12	Introduction to Data Preprocessing	**2**
13	Introduction to Machine Learning Models	**2**

14	Introduction to model cross-validation and model performance analysis	**2**
	Total Lab Hours	**28**

Suggested/Resources:

- Python Data Science Handbook by Jake VanderPlas, 2017.
- Data Science and analytics with python by Jesus Rogel-Salazar.
- Introduction to Probability Theory and Statistical Inference by H.J. Larson, John Wiley & Sons, (2005) 3rd ed.
- https://bit.ly/3aONiOo
- https://bit.ly/2GvlBfs
- https://bit.ly/2uIJuxg

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Project-1	10 Marks
4	Lab Assessment	45 Marks
5	Lab Attendance	5 Marks
	Total	100 marks

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Avg
CO1	3	3	3	3	2	2	1	1	1	1	1	1	1.8
CO2	3	3	3	3	3	1	1	1	1	1	1	3	2
CO3	3	3	2	3	2	3	2	1	1	1	2	1	2
CO4	3	3	3	2	3	2	1	1	1	1	1	1	1.8
CO5	2	2	3	3	3	3	1	1	1	1	1	1	1.8
CO6	2	3	3	3	2	2	2	2	2	2	2	2	2.3
Avg	2.7	2.8	2.8	2.8	2.5	2.2	1.3	1.2	1.2	1.2	1.3	1.5	2

Digital Forensics

COURSE CODE: XXXXXXXX COURSE CREDITS: 2 CORE/ELECTIVE: ELECTIVE L-T-P: 2-0-0
Pre-requisite: Cryptography and Security, Computer Networks

Course Objectives:

1. To understand underlying principles and many of the techniques associated with digital forensic practices and cybercrime
2. To explore practical knowledge about ethical hacking Methodology.
3. To learn the importance of evidence handling and storage for various devices
4. To develop an excellent understanding of current cybersecurity issues (Computer Security Incident) and analyzed the ways that exploit insecurities.
5. To investigate attacks, IDS .technical exploits and router attacks and "Trap and Trace" computer networks.
6. To apply digital forensic knowledge to use computer forensic tools and investigation report writing

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	Introduction to Cyber Crime and Ethical Hacking	Familiarity
CO-2	Introduction to Digital Forensics and Digital Evidences	Familiarity
CO-3	Computer Security Incident Response Methodology	Assessment
CO-4	Forensic Duplication and Disk Analysis, and Investigation Data Analysis	Assessment
CO-5	Network Forensics Incidents, Using Routers as Response Tools	Usage
CO-6	Forensic Investigation Report and Forensic Tools	Usage

Course Contents:

Unit	Contents	Lectures Required
1	Introduction of Cybercrime: Types of cybercrime, categories of cybercrime, Computers' roles in crimes, Prevention from Cybercrime, Hackers, Crackers, Phreakers Ethical Hacking: Difference between Hacking and Ethical hacking: Steps of Ethical Hacking, Exploring some tools for ethical hacking: reconnaissance tools, scanning tools	5
2	Digital Forensic, Rules for Digital Forensic The Need for Digital Forensics, Types of Digital Forensics, Ethics in Digital Forensics,	5

	Digital Evidences: Types and characteristics and challenges for Evidence Handling	
3	Introduction to Computer Security Incident Goals of Incident Response, Incident Response Methodology, Formulating Response Strategy, IR Process – Initial Response, Investigation, Remediation, Tracking of Significant, Investigative Information, Reporting Pre Incident Preparation, Incident Detection, and Characterization. Live Data Collection: Live Data Collection on Microsoft Windows Systems: Live Data Collection on Unix-based Systems	**5**
4	Forensic Duplication Forensic Image Formats, Traditional Duplication, Live System Duplication, Forensic Duplication tools Disk and File System Analysis: Media Analysis Concepts, File System Abstraction Model The Sleuth Kit: Installing the Sleuth Kit, Sleuth Kit Tools Partitioning and Disk Layouts: Partition Identification and Recovery, Redundant Array of Inexpensive Disks Special Containers: Virtual Machine Disk Images, Forensic Containers Hashing, Carving: Foremost, Forensic Imaging: Deleted Data, File Slack, Data Analysis, Analysis Methodology Investigating Windows systems, Investigating UNIX systems, Investigating Applications, Web Browsers, Email, Malware Handling: Static and Dynamic Analysis	**5**
5	Technical Exploits and Password Cracking, Introduction to Intrusion Detection systems, Types of IDS Understanding Network intrusion and attacks, Analyzing Network Traffic, Collecting Network-based evidence, Evidence Handling. Investigating Routers, Handling Router Table Manipulation Incidents, Using Routers as Response Tools	**4**
6	Report: Goals of Report, Layout of an Investigative Report, Guidelines for Writing a Report, sample for writing a forensic report. Computer Forensic Tools: need and types of computer forensic tools, tasks performed by computer forensic tools. Study of open-source Tools like SFIT, Autopsy, etc. to acquire, search, analyze and store digital evidence	**4**
	Total Lecture Hours	**28**

Suggested Text Book(s):

- Jason Luttgens, Matthew Pepe, Kevin Mandia, “Incident Response and computer forensics”,3rd Edition Tata McGraw Hill, 2014.
- Nilakshi Jain, Dhananjay Kalbande, ”Digital Forensic: The fascinating world of Digital Evidences ” Wiley India Pvt Ltd 2017.
- Cory Altheide, Harlan Carvey ”Digital forensics with open source tools “Syngress Publishing, Inc. 2011.
- Chris McNab, Network Security Assessment, By O'Reilly.

Suggested Reference Book(s):

- Clint P Garrison "Digital Forensics for Network, Internet, and Cloud Computing A forensic evidence guide for moving targets and data , Syngress Publishing, Inc.2010
- Bill Nelson,Amelia Phillips,Christopher Steuart, "Guide to Computer Forensics and Investigations" . Cengage Learning, 2014
- Debra Littlejohn Shinder Michael Cross "Scene of the Cybercrime: Computer Forensics Handbook", 2nd Edition Syngress Publishing, Inc.2008.
- Marjie T. Britz, Computer Forensics and Cyber Crime, Pearson, Third Edition.

Evaluation Scheme:

S No	Exam	Marks	Duration	verage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	1.8
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	2
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	1.8
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	2.1
CO-5	2	2	2	2	3	1	1	1	2	2	1	2	1.8
CO-6	2	3	3	3	2	1	1	1	2	3	2	2	2.1
Average	2	2.5	2.5	2.5	2.5	1	1	1	2	2.3	1.5	2	1.9

Digital Forensics Lab

COURSE CODE: XXXXXXXX COURSE CREDITS: 1 CORE/ELECTIVE: ELECTIVE L-T-P: 0-0-2
Pre-requisite: Cryptography and Security, Computer Networks

Course Objectives:

1. To understand underlying principles and many of the techniques associated with digital forensic practices and cybercrime
2. To explore practical knowledge about ethical hacking Methodology.
3. To learn the importance of evidence handling and storage for various devices
4. To develop an excellent understanding of current cybersecurity issues (Computer Security Incident) and analyzed the ways that exploit insecurities.
5. To investigate attacks, IDS .technical exploits and router attacks and "Trap and Trace" computer networks.
6. To apply digital forensic knowledge to use computer forensic tools and investigation report writing

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	Introduction to Cyber Crime and Ethical Hacking	Familiarity
CO-2	Introduction to Digital Forensics and Digital Evidences	Familiarity
CO-3	Computer Security Incident Response Methodology	Assessment
CO-4	Forensic Duplication and Disk Analysis, and Investigation Data Analysis	Assessment
CO-5	Network Forensics Incidents, Using Routers as Response Tools	Usage
CO-6	Forensic Investigation Report and Forensic Tools	Usage

Course Contents:

Unit	Contents	Hours
1	Use a Web Search Engine, and search for companies specializing in computer forensics. Select three and write a two-to-three paper comparing what each company does.	**2**
2	Search the internet for articles on computer crime prosecutions. Find at least two. Write one or two pages summarizing the two articles and identify the key features of the decisions you find in your search.	**2**
3	Using a search engine, search for various computer forensics tools.	**2**
4	Preparing and processing of investigations. Try to examine and identify the evidence from the drives.	**2**
5	Extracting of files that have been deleted.	**2**
6	Illustrate any data acquisition method and validate it. Use an open-source	**2**

	data acquisition tool.	
7	You're investigating an internal policy violation when you find an e-mail about a serious assault for which a police report needs to be filed. What should you do? Write a two-page paper specifying who in your company you need to talk to first and what evidence must be turned over to police.	**2**
8	Create a file on a USB drive and calculate its hash value using FTK Imager. Change the file and calculate the hash value again to compare the files.	**2**
9	Compare two files created in Microsoft office to determine whether the files are different at the hexadecimal level. Keep a log of what you find.	**2**
10	Illustrate the analysis of forensics data.	**2**
11	Illustrate the validating of forensics data.	**2**
12	Locate and extract (JPEG) files with altered extensions.	**2**
13	Examine an E-mail message.	**2**
14	Investigate an E-mail message.	**2**
	Total Lab Hours	**28**

Suggested Text Book(s):

- "Computer Forensics and Investigations", Nelson, Phillips Enfinger, Steuart, Cengage Learning.

Suggested Reference Book(s):

- Brian Carrier, "File System Forensic Analysis" , Addison Wesley, 2005
- Dan Farmer & Wietse Venema ,"Forensic Discovery", Addison Wesley, 2005
- Eoghan Casey , ―Digital Evidence and Computer Crime ―, Edition 3, Academic Press, 2011
- Chris Pogue, Cory Altheide, Todd Haverkos ,Unix and Linux Forensic Analysis DVD ToolKit, Syngress Inc. , 2008
- Harlan Carvey ,Windows Forensic Analysis DVD Toolkit, Edition 2, Syngress Inc. , 2009
- Harlan Carvey ,Windows Registry Forensics: Advanced Digital Forensic Analysis of the Windows
- Registry , Syngress Inc, Feb 2011
- Eoghan Casey, Handbook of Digital Forensics and Investigation, Academic Press, 2009
- M Sonka, V Hlavac and R Boyle, Image Processing, Analysis and Machine Vision, PWS
- Pratt.W.K., Digital Image Processing, John Wiley and Sons, New York, 1978

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Project-1	10 Marks
4	Lab Assessment	45 Marks
5	Lab Attendance	5 Marks
	Total	100 marks

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	1.8
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	2
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	1.8
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	2.1
CO-5	2	2	2	2	3	1	1	1	2	2	1	2	1.8
CO-6	2	3	3	3	2	1	1	1	2	3	2	2	2.1
Average	2	2.5	2.5	2.5	2.5	1	1	1	2	2.3	1.5	2	1.9

Foundation for Data Science and Visualization

COURSE CODE: XXXXXXXX COURSE CREDITS: 2 CORE/ELECTIVE: ELECTIVE L-T-P: 2-0-0

Pre-requisite: Basic knowledge of high school mathematics and reasonable programming experience.

Course Objectives:

- Asking the correct questions and analyzing the raw data.
- Modeling the data using various complex and efficient algorithms.
- Visualizing the data to get a better perspective.
- Understanding the data to make better decisions and find the final result.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	Understanding the basics of data science	Familiarity
CO-2	Using versatile and flexible languages (Python and R programming) for supporting data science	Usage
CO-3	Using data processing for collecting and manipulating the data into the usable and desired form	Usage
CO-4	Using data visualization to easily access the huge amount of data in visuals	Usage
CO-5	Using statistics to collect and analyze the numerical data in a large amount and finding meaningful insights from i	Usage
CO-6	Understanding linear algebra to represent, model, synthesize and summarize the complex data	Usage

Course Contents:

Unit	Contents	Lectures Required
1	**Data Science an Introduction:** Computer Science, Data Science, and Real Science, What is Data Science? Need for Data Science, Data Science Components, Tools for Data Science, Data Science Lifecycle, Applications of Data Science	2

2	**Python and R Programming for Data Science for Data Science:** Introduction to Python Programming (Python Basics, Python Data Structures, Python Programming Fundamentals, Working with Data in Python, Working with NumPy, Pandas, SciPy, and Matplotlib). Introduction to R Programming (R basics, Data structures in R, R Programming fundamentals, Working with Data in R, Stings, and Dates in R, Discover R's packages to do graphics)	**5**
3	**Data Processing:** Data Operations, Data cleansing, Processing CSV Data, Processing JSON Data, Processing XLS Data, Relational databases, NoSQL Databases, Date and Time, Data Wrangling, Data Aggregation, Reading HTML Pages, Processing Unstructured Data, Word tokenization, Stemming and Lemmatization	**5**
4	**Statistical Data Analysis:** Measuring Central Tendency, Measuring Variance, Normal Distribution, Binomial Distribution, Poisson Distribution, Bernoulli Distribution, P-Value, Correlation, Chi-square Test, Linear Regression	**5**
5	**Linear Algebra:** Visualizing Matrix Operations (Matrix Addition, Matrix Multiplication, Applications of Matrix Multiplication, Identity Matrices and Inversion, Matrix Inversion and Linear Systems, Matrix Rank) Factoring Matrices (Why Factor Feature Matrices, LU Decomposition, and Determinants), Eigenvalues and Eigenvectors (Properties of Eigenvalues, Computing Eigenvalues), Eigenvalue Decomposition (Singular Value Decomposition, Principal Components Analysis)	**5**
6	**Data Visualization:** Chart Properties, Chart Styling, Box Plots, Heat Maps, Scatter Plots, Bubble Charts, 3D Charts, Time Series, Geographical Data, Graph Data	**6**
	Total Lecture Hours	**28**

Suggested Text Book(s):

- Data Science from Scratch by Joel Grus
- Data Science for Dummies by Lillian Pierson and Jake Porway
- An Introduction to Statistical Learning by Gareth James, Daniela Witten, et al.

Reference Book(s):

- An Introduction to Probability and Statistics by V.K. Rohatgi & A.K. Md. E. Saleh, Wiley, (2008), 3rd ed.
- Introduction to Probability Theory and Statistical Inference by H.J. Larson, John Wiley & Sons, (2005) 3rd ed.

Other useful resources (s):

- https://nptel.ac.in/courses/110/106/110106064/
- https://onlinecourses.nptel.ac.in/noc18_cs28/pr eview

Evaluation Scheme:

S No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Foundation for Data Science and Visualization)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	3	2	1	1	1	3	2	2	1	1.8
CO-2	3	3	3	3	3	1	1	2	2	2	1	1	2.1
CO-3	2	2	2	2	1	1	2	2	2	2	1	2	1.8
CO-4	3	3	3	3	2	1	1	3	2	3	3	2	2.4
CO-5	3	2	3	3	1	1	2	1	1	3	2	1	1.9
CO-6	2	2	1	2	2	2	3	2	1	2	3	1	1.9
Average	2.5	2.3	2.3	2.7	1.8	1.2	1.7	1.8	1.8	2.3	2	1.3	2.0

Data Science and Visualization Lab

COURSE CODE: XXX COURSE CREDITS: 1 CORE/ELECTIVE: ELECTIVE L-T-P: 0-0-2

Pre-requisite: Python/ R Programming and Machine Learning

Course Objectives:

- Asking the correct questions and analyzing the raw data.
- Modeling the data using various complex and efficient algorithms.
- Visualizing the data to get a better perspective.
- Understanding the data to make better decisions and find the final result.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	Understanding the basics of data science	Familiarity
CO-2	Using versatile and flexible languages (Python and R programming) for supporting data science	Usage
CO-3	Using data processing for collecting and manipulating the data into a usable and desired form	Usage
CO-4	Using statistics to collect and analyze the numerical data in a large amount and finding meaningful insights from i	Usage
CO-5	Understanding linear algebra to represent, model, synthesize and summarize the complex data	Usage
CO-6	Using data visualization to easily access the huge amount of data in visuals	Usage

List of Experiments

S No	Description	Hours
1	Write a Python/R program to create a vector of a specified type and length. Create a vector of numeric, complex, logical, and character types of length 6. Write a Python/R program to add two vectors of integer type and length 3. Write a Python/R program to create a list containing a vector, a matrix, and a list and remove the second element Write a Python/R program to create a list containing a vector, a matrix, and a list and update the last element.	**2**
2	Write Python/R programs to solve the following tasks in both of them. Read numbers from a file, and print them out in sorted order. Read a text file, and count the total number of words. Read a text file, and count the total number of distinct words. Read a file of numbers, and plot a frequency histogram of them	**2**
3	**Statistical Data Analysis**	**2**

Write a program to solve linear regression for a given data set.

$Y = ax + b$ where

$a = (n\Sigma xy - \Sigma x\Sigma y) / n\Sigma x^2 - \Sigma(x)^2$

$b = (\Sigma y - a\Sigma x)/n$

Here

Y: response variable X: predicator variable

a, b: regression coefficients Read data set

X	Y
-2	-1
1	1
3	2

4

Statistical Data Analysis

Solve the linear regression for a given data set, and also predict sales in the year 2012.

Year	Sales
2005	12
2006	19
2007	29
2008	37
2009	45

2

5

Statistical Data Analysis

Compute Logistic Regression for Organization dataset.

Response Variables

Y = Compensation in rupees Prediction Variables

X_1 = Experience in years

X_2 = Education in years (after 10th standard) X_3 = Number of Employees Supervised

X_4 = Number of Projects Handled

S No	Compensation	Experience	Education	Number supervised	Projects
1	1500	2	5	4	10
2	1650	3	6	5	10
3	1750	3	3	5	12
4	1400	2	3	3	9
5	2000	4	4	6	15
6	2200	5	6	6	14
7	2100	1	5	4	12
8	2750	5	8	7	15
9	2900	8	9	8	25
10	1100	3	3	2	7
11	1000	4	2	1	5
12	1350	6	4	4	12
13	1550	4	6	4	11

2

	Here you will get an error as y- value must be $0 < 1$. So modify Y values.	
6	**Statistical Data Analysis** In an entrance examination, there are twenty multiple-choice questions. Each question has four options, and only one of them is correct. Find the probability of having seven or less than seven correct answers if a student attempts to answer every question at random. Let us assume that the test scores an entrance exam fit a normal distribution where the mean test score is 67, and the standard deviation is 13.7. Calculate the percentage of students scoring 80 or more in the exam?	**2**
Mid-Semester Lab Examination		**2**
7	**Linear Algebra** Compare the speed of a library function for matrix multiplication to your implementation of the nested loops algorithm. How much faster is the library on products of random $n \times n$ matrices, as a function of n as n gets large? What about the product of an $n \times m$ and $m \times n$ matrix, where $n \times m$? By how much do you improve the performance of your implementation to calculate $C = A \times B$ by first transposing **B** internally, so all dot products are computed along rows of the matrices to improve cache performance?	**2**
8	**Linear Algebra** Implement Gaussian elimination for solving systems of equations, $C \times X = Y$. Compare your implementation against a popular library routine for: Speed: How does the run time compare, for both dense and sparse coefficient matrices? Accuracy: What is the size of the numerical residuals $CX - Y$, particularly as the condition number of the matrix increases. Stability: Does your program crash on a singular matrix? What about almost singular matrices, created by adding a little random noise to a singular matrix?	**2**
9	**Data Visualization** Construct a revealing visualization of some aspect of your favorite data set, using: A well-designed table. A dot and/or line plot. A scatter plot. A heatmap. A bar plot or pie chart. A histogram. A data map.	**2**
10	**Data Visualization** Create ten different versions of line charts for a particular set of (x, y) points. Which ones are best and which ones worst? Explain why.	**2**
11	**Data Visualization**	**2**

	Construct scatter plots for sets of 10, 100, 1000, and 10,000 points. Experiment with the point size to find the most revealing value for each data set.	
12	**Data Visualization** Experiment with different color scales to construct scatter plots for a particular set of (x, y, z) points, where color is used to represent the z dimension. Which color schemes work best? Which are the worst? Explain why.	**2**
End-Semester Lab Examination		**2**
	Total Lab hours	**28**

Suggested Text Books:

- Python Data Science Hand Book Jake VanderPlas
- Mastering Python for Data Science - by Samir Madhavan.
- R Programming for Data Science by Roger D. Peng

Reference Books:

- Python Data Science: Hands-on Learning for Beginners Kindle Edition by Travis Booth (Author)
- Data Science with R: A Step By Step Guide with Visual Illustrations & Examples by Andrew Oleksy
- R for Data Science: Import, Tidy, Transform, Visualize, and Model Data by Hadley Wickham (Author), Garrett Grolemund

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Project-1	10 Marks
4	Lab Assessment	45 Marks
5	Lab Attendance	5 Marks
	Total	100 marks

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Data Science and Visualization Lab)	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**Average**
CO-1	2	2	2	3	2	1	1	1	3	2	2	1	1.8
CO-2	3	3	3	3	3	1	1	2	2	2	1	1	2.1
CO-3	2	2	2	2	1	1	2	2	2	2	1	2	1.8
CO-4	3	3	3	3	2	1	1	3	2	3	3	2	2.4
CO-5	3	2	3	3	1	1	2	1	1	3	2	1	1.9
CO-6	2	2	1	2	2	2	3	2	1	2	3	1	1.9
Average	2.5	2.3	2.3	2.7	1.8	1.2	1.7	1.8	1.8	2.3	2	1.3	2.0

Computational Data Analysis

COURSE CODE: XXXXXXXX COURSE CREDITS: 2 CORE/ELECTIVE: ELECTIVE L-T-P: 2-0-0

Pre-requisite: Basics of probability and statistics

Course Objectives:

1. To provide students with the foundational knowledge of topics such as probability and statistics and algorithms to solve data analysis problems arising in practical applications,
2. To enable students to effectively apply computational methods to solve exemplar data analysis problems arising in relevant applications.
3. Have a good understanding of the fundamental issues and challenges of machine learning.
4. Have an understanding of the strengths and weaknesses of many popular machine learning approaches.
5. Be able to design and implement various machine learning algorithms in a range of real-world applications.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	To learn the basic concepts and terminology in statistics used in machine learning	Familiarity
CO-2	To understand the concepts associated with the classification and experimental evaluation of classification algorithms	Familiarity
CO-3	To learn about clustering and unsupervised learning	Assessment
CO-4	To learn about various techniques for selecting relevant features selection.	Assessment
CO-5	To learn about various techniques for enhancing the performance of basic machine learning algorithms.	Usage

Course Contents:

Unit	Contents	Lectures Required
1	Supervised Learning, Discriminative Algorithms: Supervised Learning Concept, Linear Regression, Maximum Likelihood, Normal Equation, Gradient Descent, Stochastic Gradient, SVRG. Linear Classification, Logistic Regression.	**5**
2	Generative Algorithms: Multivariate Normal, Linear Discriminant Analysis, Naive Bayes,	**5**

	Laplacian Smoothing, Multiclass Classification, K-NN Multi-class Fisher Discriminant Analysis, Multinomial Regression Support Vector Machines and Kernel Methods: Intuition, Geometric Margins, Optimal Margin Classifier, Multiclass SVM	
3	Unsupervised Learning: EM Algorithm, DBSCAN, k-means, Hierarchical clustering	**4**
4	Regularization, Model Selection, and Optimization: Cross-Validation, Bayesian Optimization Bayesian Regression, Bayesian Logistic Regression Forward and Backward Regression, Lasso, elastic-net. Proximal Gradient, Prox-SVRG. Coordinate Proximal Gradient, Pathwise Coordinate Descent	**5**
5	Feature Selection: Information Gain, Correlation Coefficient, Chi-square test, PCA	**4**
6	Ensemble Learning: Bagging, Boosting, Stacking, Entropy, Building Tree, Bagging features, Bagging Samples, Random Forest, Adaboost, Gradient Tree Boosting	**5**
	Total Lecture Hours	**28**

Suggested Text Book(s):

- Tom Mitchell, "Machine Learning", McGraw Hill, 1997, ISBN 0070428077
- Introduction to Machine Learning Edition 2, by Ethem Alpaydin.
- T. Hastie, R. Tibshirani, & J. H. Friedman, "The Elements of Statistical Learning: Data Mining, Inference, and Prediction", Springer Verlag, 2001.

Suggested Reference Book(s):

- The Elements of Statistical Learning, 2nd Edition, Hastie, Tibshirani and Friedman.
- Foundations of Machine Learning, Mohri, Rostamizadeh and Talwalker
- Richard o. Duda, Peter E. Hart, and David G. Stork, "Pattern Classification", John Wiley Asia, 2006

Other useful resources (s):

- Link to NPTEL course contents: https://nptel.ac.in/courses/106106139/
- https://nptel.ac.in/courses/110106064/

Evaluation Scheme:

S No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Computational Data Analysis)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	1.8
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	2
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	1.8
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	2.1
CO-5	1	2	2	1	3	2	1	1	1	1	1	1	1.4
Average	1.8	2.4	2.4	2.2	2.6	1.2	1	1	1.8	2	1.4	1.8	1.8

Computational Data Analysis Lab

COURSE CODE: XXXXXXXX COURSE CREDITS: 1 CORE/ELECTIVE: ELECTIVE L-T-P: 0-0-2
Pre-requisite: Python Programming Language

Course Objectives:

1. To develop students' skills in software development techniques using one or more high- level programming languages relevant to data analytics.
2. To enable students to effectively apply computational methods to solve exemplar data analysis problems arising in relevant applications.
3. To learn the implementation of classification techniques for any dataset.
4. To conduct experiments for clustering techniques for any dataset.
5. To discuss different classification and clustering algorithms based on the analysis of results obtained from the experimental evaluation.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO1	To learn and implement the basic concepts and terminology in statistics used in machine learning	Usage
CO2	To implement classification and clustering algorithms in python	Usage
CO3	To implement feature selection methods in Python	Usage
CO4	To compare different algorithms based on some common factors	Assessment

List of Experiments

S No	Description	Hours
1	Visualize data using any plotting framework How to upload a dataset How to retrieve rows and data in the dataset How to delete a certain column in the dataset How to display minimum, maximum value of a particular feature How to display certain rows of a dataset	**2**
2	Visualize data using any plotting framework How to display certain rows of a dataset How to insert a new row at a particular index Visualization of the dataset (scatterplot, histogram) To find the sum of null values in each column Extracting certain columns	**2**
3	Implement SVM using different kernel methods like Gaussian Radial Basis Function (RBF), Laplace RBF kernel, ANOVA Radial Basis kernel,	**2**

	Polynomial Kernel.	
4	Implement Naïve Bayes using Bernoulli model and Multinomial model (Laplace smoothing and Log-Transformation).	**2**
5	Implement K-NN and DT	**2**
6	Implement Linear regression and Logistic regression	**2**
7	Implement the following clustering techniques: K-means, *Hierarchical,*	**2**
8	Implement the following clustering techniques: *DBSCAN,* EM Algorithm	**2**
9	Implement various feature selection methods Information Gain Correlation Coefficient	**2**
10	Implement various feature selection methods Chi-square test PCA	**2**
11	Implement the following ensemble techniques: XGBoost, AdaBoost	**2**
12	Implement the following ensemble techniques: Gradient Boosting, Bagging	**4**
	Total Lab hours	**28**

Suggested/Resources:

- Tom Mitchell, "Machine Learning", McGraw Hill, 1997, ISBN 0070428077
- Sebastian Raschka, "Python Machine Learning", Packt Publishing Ltd.
- Andreas C. Müller, Sarah Guido, "Introduction to Machine Learning with Python", O'Reilly Media, Inc.
- Sunila Gollapudi, "Practical Machine Learning", Packt Publishing Ltd
- Wes McKinney, "Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython", O'Reilly Media, Inc.
- Willi Richert, "Building Machine Learning Systems with Python", Packt Publishing Ltd.

Link to topics related to course:

- https://www.python-course.eu/machine_learning.php
- https://www.analyticsvidhya.com/blog/2018/05/24-ultimate-data-science-projects-to- boost-your knowledge-and-skills/
- https://www.datacamp.com/

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Attendance	10 Marks
4	Project	20 Marks
5	Lab Assessment	30 Marks
	Total	**100 marks**

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	Average
CO-1	3	2	2	2	3	1	1	1	1	1	2	2	1.8
CO-2	3	3	3	3	3	2	1	2	2	1	2	3	2.3
CO-3	3	3	2	3	3	2	1	2	2	1	2	3	2.3
CO-4	3	3	3	3	3	2	1	2	2	1	2	3	2.3
Average	3	2.8	2.5	2.8	3	1.8	1	1.8	1.8	1	2	2.8	2.2

Big Data and Hadoop

COURSE CODE: XXXXXXXX COURSE CREDITS: 2 CORE/ELECTIVE: ELECTIVE L-T-P: 2-0-0

Pre-requisite: None

Course Objectives:

1. Understand the fundamentals of Concepts in BigData and Hadoop etc
2. Understand the fundamentals of Hadoop etc.
3. Be able to use the HDFS file system, debug and run simple Java programs for HDFS.
4. Be aware of the important topics and principles of software development and write better &more maintainable code
5. Be able to program using advanced Java topics like JDBC, Servlets, and JSP.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	What is big data: introduction to the data lake, why do companies care for big data, why do we out of big data, social media	Familiarity
CO-2	History of Hadoop, the importance of HDFS: Hadoop timeline, why Hadoop, Hadoop 1.x architecture, core components, and job process	Assessment
CO-3	Different phases in Map Reduce: input-output formats in each phase, modeling real-world applications in map-reduce, understanding map-reduce program execution, problems in map-reduce	Assessment
CO-4	Apache Hive, Apache PIG: introduction to Hive meta store, SQL vs Hive, Hive query language, managed and external tables, querying data, introduction to PIG, map-reduce vs PIG, PIG in local mode, PIG in the map-reduce mode	Usage
CO-5	SQOOP: Introduction to SQOOP framework, SQOOP flavors of import, SQOOP flavors of export, SQOOP CLI options	Usage
CO-6	FLUME: Introduction to messaging service, applications of a messaging service, FLUME architecture framework, working of a FLUME agent, understanding FLUME configurations, Hadoop ecosystem labs, importing data from MYSQL and querying it using HIVE, configuring FLUME agent to listen to local log files	Assessment

Course Contents:

Unit	Contents	Lectures Required
1	What is big data: introduction to the data lake, why do companies care for big data, why do we out of big data, social media	4
2	History of Hadoop, the importance of HDFS: Hadoop timeline, why Hadoop, Hadoop 1.x architecture, core components, and job process	4
3	Different phases in Map Reduce: input-output formats in each phase, modeling real-world applications in map-reduce, understanding map-reduce program execution, problems in map-reduce	5
4	Apache Hive, Apache PIG: introduction to Hive meta store, SQL vs Hive, Hive query language, managed and external tables, querying data, introduction to PIG, map-reduce vs PIG, PIG in local mode, PIG in a map-reduce mode	4
5	SQOOP: Introduction to SQOOP framework, SQOOP flavors of import, SQOOP flavors of export, SQOOP CLI options	6
6	FLUME: Introduction to messaging service, applications of a messaging service, FLUME architecture framework, working of a FLUME agent, understanding FLUME configurations, Hadoop ecosystem labs, importing data from MYSQL and querying it using HIVE, configuring FLUME agent to listen to local log files	5
	Total Lecture Hours	**28**

Suggested Text Book(s):

- Big Data and Hadoop, V.K. Jain (https://books.google.co.in/books?id=i6NODQAAQBAJ&printsec=frontcover&redir_esc=y#v=onepage&q&f=false).
- Big Data and Hadoop, MAYANK BHUSHAN**. Other useful resources (s):**

- https://www.youtube.com/watch?v=1vbXmCrkT3Y

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered up to T-1
2	T-2	25	1.5 Hours	Syllabus covered up to T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Big Data and Hadoop)	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**Average**
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	**1.8**
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	**2**
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	**1.8**
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	**2.1**
CO-5	2	3	1	1	2	3	2	1	2	3	3	2	**2.1**
CO-6	2	3	3	2	1	3	2	2	3	3	2	2	**2.3**
Average	**2**	**2.7**	**2.3**	**2.2**	**2.2**	**1.7**	**1.3**	**1.2**	**2.2**	**2.5**	**1.8**	**2**	**2**

Big Data and Hadoop Lab

COURSE CODE: XXXXXXXX **COURSE CREDITS:** 1 **CORE/ELECTIVE:** ELECTIVE **L-T-P:** 0-0-2

Pre-requisites: An understanding in practicalities of big data and Hadoop to any programming language (Preferably, C)

Course Objective

The lab course provides a complete description of the inner working of big data and Hadoop. The main focus is on the design of big data techniques. The course also aims to convey the language specifications, use of file management tasks, and map-reduce behind the design of algorithms. It builds an understanding of various techniques like map-reduce, pig Latin scripts, etc.

Course Outcomes (COs):

S No	Course outcomes	Level of Attainment
CO-1	Perform setting up and Installing Hadoop in various operating modes	Familiarity
CO-2	Implement file management tasks in Hadoop	Familiarity
CO-3	Running a Map-Reduce Paradigm	Computational skills
CO-4	Run Pig then write Pig Latin scripts	Technical skills

List of Experiments

S No	Topic	Hours
1	Implement the following data structures in Java: Linked list, stacks, queues, Set and Map	**2**
2	Perform setting up and Installing Hadoop in its three operating modes: Standalone, Pseudo distributed, Fully distributed Use web-based tools to monitor your Hadoop setup.	**4**
3	Implement the following file management tasks in Hadoop: Adding files and directories Retrieving files Deleting files Hint: A typical Hadoop workflow creates data files (such as log files) elsewhere and copies them into HDFS using one of the above command-line utilities.	**4**

4	Run a basic Word Count Map Reduce program to understand Map Reduce Paradigm	**4**
5	Write a Map Reduce program that mines weather data. Weather sensors collecting data every hour at many locations across the globe gather a large volume of log data, which is a good candidate for analysis with Map Reduce since it is semi-structured and record-oriented	**4**
6	Implement Matrix Multiplication with Hadoop Map Reduce	**2**
7	Install and Run Pig then write Pig Latin scripts to sort, group, join, project, and filter your data	**4**
8	Install and Run Hive then use Hive to create, alter, and drop databases, tables, views, functions, and indexes	**4**
	Total Lab Hours	**28**

Evaluation Scheme

S No	Exam	Coverage/Scope of Examination	Marks
1	Mid Term Test	Viva and Written Exam	20
2	End Term Test	Viva and Written Exam	20
3	Lab Records		15
4	Teacher Assessment	(Quality and quantity of experiment performed, learning laboratory skills)	30
5	Attendance and discipline in lab		15
	Total		**100**

Reference Books:

- Big Data and Hadoop, V.K. Jain
- Big Data and Hadoop, MAYANK BHUSHAN

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes	O- 1	O- 2	O- 3	O- 4	O- 5	O- 6	O- 7	O- 8	O- 9	PO- 10	PO- 11	PO- 12	Average
CO-1	3	2	2	2	1	3	3	2	1	3	2	1	2.1
CO-2	3	3	2	2	1	3	3	1	3	3	3	1	2.3
CO-3	3	3	2	2	2	2	2	1	2	3	3	2	2.3
CO-4	3	3	3	2	2	2	3	2	2	1	2	2	2.3
CO-5	3	3	2	1	1	3	3	1	3	3	3	1	2.3
Average	3	2.8	2.2	1.8	1.4	2.6	2.8	1.4	2.2	2.6	2.6	1.4	2.2

Computability, Complexity, and Algorithms

COURSE NAME: Computability, Complexity and Algorithms COURSE CODE: XXXXXXXX
COURSE CREDITS: 3 CORE/ELECTIVE: ELECTIVE L-T-P: 3-0-0
Pre-requisite: None

Course Objectives:

1. Learn to analyze algorithms for Time and Space Complexity
2. Learn asymptotic notations for performance analysis of algorithms.
3. Learn various computational and complexity of randomizedalgorithms.
4. Apply important algorithmic design paradigms and methods of analysis.
5. Synthesize efficient mathematical induction and asymptotic notations.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	Introduction of algorithms	Familiarity
CO-2	Demonstrate familiarity with major topics of algorithm analysis.	Assessment
CO-3	Introduction of computability theory.	Assessment
CO-4	Analysis of time complexity of randomized algorithms.	Usage
CO-5	An introduction of probability and randomized algorithms	Usage
CO-6	A brief description of probability, mathematical induction, and asymptotic notations	Assessment

Course Contents:

Unit	Contents	Lectures Required
1	**Introduction to algorithm analysis:** Basic introduction of algorithms, divide and conquer paradigm, Asymptotic notations, Probabilistic and randomized algorithms.	7
2	**Advanced algorithm I:** Dynamic programming, Greedy algorithms, and amortized analysis.	7
3	**Advanced topics in algorithms II:** Graph algorithm, flow in networks, bipartite matching's.	6
4	**Computability Theory:** Turing machines, decidability, mapping reducibility	6
5	**Complexity Theory:** Introduction to time complexity, NP and NP-completeness, Approximation algorithms, and derandomization.	7
6	**Probabilistic and Randomized Algorithms:** Probabilistic algorithms; Randomizing deterministic algorithms, Monte Carlo and	6

	Las Vegas algorithms; Probabilistic numeric Algorithms.	
7	**Supplementary material: Mathematical induction, asymptotic notations, and probability**	**3**
	Total Lecture Hours	**42**

Suggested Text Book(s):

- V. J. Rayward-Smith, *A first course in computability,* McGraw Hill, 1995? An introductory paperback that covers Parts I and III of the course, and some of Part II. More detailed than this course.

- D. Harel, *The Science of Computing,* Addison-Wesley, 1989. A good book for background and motivation, with fair coverage of this course and a great deal more. Some may find the style diffuse. Less detailed than this course

Suggested Reference Book(s):

- Robert Sedgewick, *Algorithms,* Addison-Wesley, 2nd ed., 1988. A practical guide to many useful algorithms and their implementation. A reference for Part II of the course.
- J. Bell, M. Machover, *A course in mathematical logic,* North-Holland, 1977. A good mathematical text, for those who wish to read beyond the course.
- G. Boolos, R. Jeffrey, *Computability and Logic,* Cambridge University Press, 1974

Other useful resources (s):

- youtube.com/playlist?list=PLLkyyG3XCR1mCH_XAWGdm9u4h_VTIRYC-

Evaluation Scheme:

S No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered up to T-1
2	T-2	25	1.5 Hours	Syllabus covered up to T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Computability, Complexity, and Algorithms)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	1.8
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	2
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	1.8
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	2.1
CO-5	2	3	1	1	2	3	2	1	2	3	3	2	2.1
CO-6	2	3	3	2	1	3	2	2	3	3	2	2	2.3
Average	2	2.7	2.3	2.2	2.2	1.7	1.3	1.2	2.2	2.5	1.8	2	2

Course Outcomes (COs) contribution to PSOs

Attainment of PSOs through COs					
Sr. No.	PSO-1	PSO-2	PSO-3	PSO-4	Average
CO-1	3	2	2	1	2
CO-2	3	3	2	2	2.5
CO-3	3	2	3	2	2.5
CO-4	3	3	2	3	2.8
CO-5	3	2	2	1	2
CO-6	3	2	1	2	2
Average Score	3	2.3	2	1.8	

Computability, Complexity and Algorithms Lab

Course Code: XXXXXXX
Course Title: Computability, Complexity and Algorithms Lab
Course Credits: 01
CORE/ELECTIVE: ELECTIVE
Semester: VIIIth Semester
: 0-0-2

Pre-requisites: An understanding in practicalities of Computability, Complexity, and Algorithms to any programming language (Preferably, C)

Course Objective
The lab course provides a complete description of the inner working of complexity and algorithms. The main focus is on the design of algorithms and computational techniques. The course also aims to convey the language specifications, use of regular expressions, and computations behind the design of algorithms.
Course Outcome (CO)

S No	Course outcomes	Level of Attainment
CO-1	Construction of dynamic and greedy algorithms	Familiarity
CO-2	Analyzing the *t*ime complexity of graph, dynamic and greedy methods	Familiarity
CO-3	Construction of minimization of automata	putational skills
CO-4	Building various probabilistic techniques	Technical skills

List of Practical

S. No	Topic	Hours
1	Write a program to read and translate integers into numbers. e.g. 1=ONE, 12 = ONE TWO and 856 = EIGHT FIVE SIX, Generate an error if the number of digits is more than 3	**2**
2	Write a program to convert infix notation to postfix notation.	**2**
3	Implement a DFA which simulates the regular expression a + (aa)*b.	**4**
4	Write a program to implement minimization of finite automata	
5	Implementation of greedy algorithms	**4**
6	Implementation of dynamic programming algorithms	
7	Program for computation of computability and complexity theory.	**4**
8	Write a program to check advanced algorithms like dynamic programming, greedy algorithm.	**4**
9	Implementation of an approximation algorithm	**4**
10	Implementation of a randomized algorithm	**4**
	Total Lab Hours	**28**

Evaluation Scheme

S No	Exam	Coverage/Scope of Examination	Marks
1	Mid Term Test	Viva and Written Exam	20
2	End Term Test	Viva and Written Exam	20
3	Lab Records		15
4	Teacher Assessment	(Quality and quantity of experiment performed, learning laboratory skills)	30
5	Attendance and discipline in lab		15
6	Total		100

Reference Booka

- V. J. Rayward-Smith, *A first course in computability,* McGraw Hill, 1995? An introductory paperback that covers Parts I and III of the course, and some of Part II. More detailed than this course.
- D. Harel, *The Science of Computing,* Addison-Wesley, 1989. A good book for background and motivation, with fair coverage of this course and a great deal more. Some may find the style diffuse. Less detailed than this course

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes	O- 1	O- 2	O- 3	O- 4	O- 5	O- 6	O- 7	O- 8	O- 9	PO- 10	PO-11	PO-12	Average
CO-1	3	2	2	1	2	3	3	2	1	3	2	1	2.1
CO-2	3	3	2	1	1	3	3	1	3	3	3	1	2.3
CO-3	3	3	1	1	2	2	2	1	2	3	3	2	2.1
CO-4	3	3	2	2	2	2	3	2	2	1	2	2	2.2
CO-5	3	3	2	1	1	3	3	1	3	3	3	1	2.3
Average	3	2.8	1.8	1.2	1.6	2.6	2.8	1.4	2.2	2.6	2.6	1.4	2.2

Course Outcomes (COs) contribution to PSOs

Attainment of PSOs through COs					
Sr. No.	PSO-1	PSO-2	PSO-3	PSO-4	Average
CO-1	3	2	2	1	2
CO-2	3	3	2	2	2.5
CO-3	3	2	3	2	2.5
CO-4	3	3	2	3	2.8
CO-5	3	2	2	1	2
CO-6	3	2	1	2	2
Average Score	3	2.3	2	1.8	

Computer and Robot Vision

Course Name: Computer and Robot Vision
Course Code: XXXXX
Course Credits: 3 CORE/ELECTIVE: ELECTIVE L-T-P: 3-0-0
Pre-requisite: Image Processing and Robotics

Course Objectives:

1. To learn fundamental image processing techniques required for computer vision.
2. To learn shape analysis and boundary tracking.
3. To learn and apply chain codes and other region descriptors.
4. To learn and apply the Hough Transform for line, circle, and ellipse detections.
5. To learn and apply 3D vision techniques, implement motion-related techniques, and Develop applications using computer vision techniques.

Course outcomes:

S No	Course outcomes	Level of Attainment
CO-1	Implement fundamental image processing techniques required for computer vision	Familiarity
CO-2	Perform shape analysis and implement boundary tracking techniques	Usage
CO-3	Apply chain codes and other region descriptors.	Usage
CO-4	Apply Hough Transform for line, circle, and ellipse detections	Usage
CO-5	Apply 3D vision techniques, implement motion-related techniques, and Develop applications using computer vision techniques	Usage

Detailed Course Contents:

Unit	Contents	Lectures required
1	**CAMERAS:** Pinhole Cameras, **Radiometry – Measuring Light:** Light in Space, Light Surfaces, Important Special Cases, **Sources, Shadows, And Shading:** Qualitative Radiometry, Sources, and Their Effects, Local Shading Models, Application: Photometric Stereo, Interreflections: Global Shading Models, **Color:** The Physics of Color, Human Color Perception, Representing Color, A Model for Image Color, Surface Color from Image Color.	8
2	**Linear Filters:** Linear Filters and Convolution, Shift Invariant Linear Systems, Spatial Frequency, and Fourier Transforms, Sampling, and Aliasing, Filters as Templates, **Edge Detection:** Noise, Estimating Derivatives, Detecting Edges, **Texture:** Representing Texture, Analysis (and Synthesis) Using Oriented	8

	Pyramids, Application: Synthesis by Sampling Local Models, Shape from Texture.	
3	**The Geometry of Multiple Views:** Two Views, **Stereopsis:** Reconstruction, Human Stereposis, Binocular Fusion, Using More Cameras, **Segmentation by Clustering:** What Is Segmentation?, Human Vision: Grouping and Gestalt, Applications: Shot Boundary Detection and Background Subtraction, Image Segmentation by Clustering Pixels, Segmentation by Graph-Theoretic Clustering,	**8**
4	**Segmentation by Fitting a Model:** The Hough Transform, Fitting Lines, Fitting Curves, Fitting as a Probabilistic Inference Problem, Robustness, **Segmentation and Fitting Using Probabilistic Methods:** Missing Data Problems, Fitting, and Segmentation, The EM Algorithm in Practice, **Tracking With Linear Dynamic Models:** Tracking as an Abstract Inference Problem, Linear Dynamic Models, Kalman Filtering, Data Association, Applications, and Examples.	**8**
5	**Geometric Camera Models:** Elements of Analytical Euclidean Geometry, Camera Parameters and the Perspective Projection, Affine Cameras and Affine Projection Equations, **Geometric Camera Calibration:** Least-Squares Parameter Estimation, A Linear Approach to Camera Calibration, Taking Radial Distortion into Account, Analytical Photogrammetry, An Application: Mobile Robot Localization, **Model-Based Vision:** Initial Assumptions, Obtaining Hypotheses by Pose Consistency, Obtaining Hypotheses by pose Clustering, Obtaining Hypotheses Using Invariants, Verification, Application: Registration In Medical Imaging Systems, Curved Surfaces, and Alignment.	**10**
	Total Lecture Hours	**42**

Evaluation Scheme:

S No	Exam	Marks	Duration	Coverage/Scope of Examination
1	Test -1	15	1 hr.	Syllabus covered upto T- 1
2	Test -2	25	1 hr 30 min.	Syllabus covered upto T- 2
3	Test - 3	35	2 hours	Full Syllabus
4	Regularity, ssignments, Quizzes.	25	Entire Semester	Regularity- 4 Assignments - 9 Quizzes - 12

Text Books:

- David A. Forsyth and Jean Ponce: Computer Vision – A Modern Approach, PHI Learning (Indian Edition), 2009.

Reference Books:

- E. R. Davies: Computer and Machine Vision – Theory, Algorithms and Practicalities, Elsevier (Academic Press), 4th edition, 2013.

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

COs	O- 1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO- 10	PO-11	PO-12	Average
CO-1	3	3	3	3	2	3	3	2	3	2	3	3	2.8
CO-2	3	3	3	3	2	3	3	2	3	2	3	3	2.8
CO-3	3	3	3	3	2	3	3	2	3	2	3	3	2.8
CO-4	3	3	3	3	2	3	3	2	3	2	3	3	2.8
CO-5	3	3	3	3	2	3	3	2	3	2	3	3	2.8
CO-6	3	2	2	3	3	3	3	2	3	2	3	3	2.7
Average	3	2.8	2.8	3	2.2	3	3	2	3	2	3	3	2.7

Computer and Robot Vision Lab

Course Name: Computer and Robot Vision Lab
Course Code: xxx
Course Credits: 01 **CORE/ELECTIVE:** ELECTIVE L-T-P: 0-0-2
Pre-requisites: Image Processing and Artificial Intelligence

Objective: The main target of computer vision is the 3-D world. Most computer vision algorithms require some form of image processing. Robot vision is to program a **robot** to "see" through a camera either mounted on the **robot**, or in a static position, takes pictures of each workpiece that the **robot** will interact with. This course integrates the two disciplines to achieve a significant purpose.

Course Outcomes (COs)

S No	Course outcomes	Level of Attainment
CO 1	To study cameras, radiometry, sources, and properties.	Familiarity
CO 2	To understand and implement linear filters, edge detection, and texture.	Usage
CO 3	To understand and implement the Geometry of Multiple Views, Stereopsis, and Segmentation by Clustering.	Usage
CO 4	To understand and implement Segmentation by Fitting a Model, Segmentation and Fitting Using Probabilistic Methods, and Tracking With Linear Dynamic Models.	Usage
CO 5	To understand and implement Geometric Camera Models and Geometric Camera Calibration.	Usage

List of experiments

S No	Topic	Hours
1	Pinhole Cameras, Radiometry – Measuring Light, Sources, Shadows, And Shading, Color	6
2	Linear Filters, Edge detection, and Texture	6
3	The Geometry of Multiple Views, Stereopsis, and Segmentation by Clustering	6
4	Segmentation by Fitting a Model, Segmentation and Fitting Using Probabilistic Methods, and Tracking With Linear Dynamic Models	6
5	Geometric Camera Models and Geometric Camera Calibration	4
	Total Lab Hours	**28**

Evaluation Scheme:

S No	Exam	Coverage/Scope of Examination	Marks
1	Mid Term Test	Viva and Written Exam	20
2	End Term Test	Viva and Written Exam	20
3	Lab Records		15
4	Teacher Assessment	(Quality and quantity of experiment performed, learning laboratory skills)	30
5	Attendance and discipline in lab		15
6	Total		100

Text Books:

- David A. Forsyth and Jean Ponce: Computer Vision – A Modern Approach, PHI Learning (Indian Edition), 2009.

Reference Books:

- E. R. Davies: Computer and Machine Vision – Theory, Algorithms and Practicalities, Elsevier (Academic Press), 4th edition, 2013.

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

S No	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	3	2	2	3	1	1	2	1	1	3	2.1
CO-2	3	3	3	3	3	3	1	1	2	1	1	3	2.3
CO-3	3	3	3	3	3	3	1	1	2	1	1	3	2.3
CO-4	3	3	3	3	3	3	1	1	2	1	1	3	2.3
CO-5	3	3	3	3	3	3	1	1	2	1	1	3	2.3
CO-6	3	3	3	3	3	3	1	1	2	1	1	3	2.3
Average	3	3	3	2.8	2.8	3	1	1	2	1	1	3	2.2

Human-Computer Interaction

Course Name: Human-Computer Interaction
Course Code: XXXXX
Course Credits: 2-0-0 CORE/ELECTIVE: ELECTIVE L-T-P: 3-0-0
Pre-requisite: Image Processing and Robotics

Course Objectives:

- Design, implement, and evaluate effective and usable graphical computer interfaces.
- Describe and apply core theories, models, and methodologies from the field of HCI.
- Describe and discuss current research in the field of HCI.
- Implement simple graphical user interfaces using the Java Swing toolkit.
- Describe special considerations in designing user interfaces for older adults.

Course Outcomes:

S No	Course outcomes	Level of Attainment
CO-1	To learn to explain why it is important to design interactive products that are usable, define key terms used in interaction design	Familiarity
CO-2	To learn to explain key theories used in the design of interactive products and to explain the importance of iteration, evaluation, and prototyping in interaction design	Familiarity
CO-3	To gather data in the context of developing a simple interactive product using suitable techniques	Technical Skills
CO-4	To produce a low-fidelity prototype for an interactive product based upon a simple list of interaction design principles and to evaluate an interactive product using suitable techniques	Technical Skills
CO-5	To communicate effectively to peers and specialists about requirements, design, and evaluation activities relating to interactive products	Key Skills
CO-6	To define a suitable program of user involvement that treats users ethically and fairly.	Key Skills

Course Contents:
:

Unit	Topic	Lectures required
1	Principles of HCI : History and Foundations of HCI, Research Frameworks in HCI, Modeling Social and Emotional Processes, Computer-Mediated Communication, Social and Embodied Interfaces I, II, Computer-Supported	4

	Collaborative Work	
2	Principles of HCI : Speech Interfaces, Games, Crowdsourcing, Information Visualization, Ubiquitous Computing, Assistive and Accessible Interfaces, Future of HCI	7
3	Human Subjects Research Methods: Introduction: Research methods in HCI, Introduction: What are elements of a research project in HCI?, Introduction: How to choose research designs?, Introduction: Methodological fit, Qualitative research: data collection, Qualitative research: data analysis	5
4	Quantitative research: Experimental design principles, Quantitative research: Step-by-step experimental design, Quantitative research: Measurement, Part I, Quantitative research: Measurement, Part II, Quantitative research: Measurement, Part III, Quantitative research: Scale construction, Quantitative research: Statistics, Part I, Quantitative research: Statistics, Part II, Quantitative research: Statistics, Part III	8
5	**Project:** Completing the required human-subjects research training program and an Institutional Review Board (IRB) application for the project, Gaining a theoretical and empirical understanding of the application domain, Applying exploratory and experimental research methods in HCI	2
6	Prototyping user interfaces, Designing exploratory and experimental studies, Gaining experience in recruiting participants, and conducting studies with human subjects, Creating generalizable knowledge on how computing can improve aspects of human life.	2
	Total Lecture Hours	28

Evaluation Scheme

S No	Exam	Marks	Duration	Coverage/Scope of Examination
1	Test -1	15	1 hr.	Syllabus covered up to T- 1
2	Test -2	25	1 hr 30 min.	Syllabus covered up to T- 2
3	Test - 3	35	2 hours	Full Syllabus
4	Regularity, Assignments, Quizzes.	25	Entire Semester	Regularity- 4 Assignments - 9 Quizzes - 12

Reference Books:

- Interaction the BCS Specialist Group on Interaction
- The Usability Professionals' Association (UPA) - founded in the US, with local chapters in the US and other countries
- Mikael Ericsson's listing of research labs and projects worldwide
- Ubiquity - ACM online magazine (general IT topics, but lots relevant to HCI)
- Alan's column and resources on HCI Education in SIGCHI Bulletin
- HCI International has a bi-monthly subscription newsletter partly about the conference,but also carrying general news, events, etc. back issues at their Press Room

- Videos in User-System Interaction - collated by Matthias Rauterberg
- The HCI Bibliography - free-access online bibliographic database on Human-Computer Interaction
- HCI Resource Network - event listings, links, jobs, and subscription-only sections, includes A-Z of HCI topics
- Hans de Graaff's HCI Index
- Craig Marion's Software Design Smorgasbord
- Gary Perlman's Resources in HCI columns from Interactions
- University of Michigan HCI resource links
- The Usability First web site has good collections of resources, particularly for web and accessibility
- Usability First glossary of usability terms
- CHI recently completed theses list
- ComputingCases.org a resource site for teaching ethical issues in computing
- SAP Usability Glossary

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Sr No	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Avg
CO-1	3	2	2	1	2	3	3	2	1	1	1	3	2
CO-2	3	3	3	2	1	1	1	3	2	1	1	3	2
CO-3	3	3	2	3	2	1	1	2	2	1	1	2	1.9
CO-4	3	3	3	3	2	1	1	3	2	1	1	2	2.1
CO-5	3	3	3	3	2	1	1	3	2	1	1	3	2.2
CO-6	3	3	3	3	2	1	1	3	2	1	1	3	2.2
Avg	3	2.8	2.7	2.5	1.8	1.3	1.3	2.7	1.8	1	1	2.7	2.1

Human-Computer Interaction Lab

Course Name: Human-Computer Interaction Lab Course Code: XXXXX
Course Credits: 1 CORE/ELECTIVE: ELECTIVE L-T-P: 0-0-2

Pre-requisite: Image Processing and Robotics Course Objective:

This course provides an introduction to and overview of the field of human-computer interaction (HCI). HCI is an interdisciplinary field that integrates theories and methodologies from computer science, cognitive psychology, design, and many other areas. Course readings will span current theory and practice in interface specification, design and evaluation, as well as current and classic research papers in HCI. Students will work on both individual and team projects to design, implement and evaluate computer interfaces. The course is open to students from all disciplines, providing them with experience working in interdisciplinary design teams. Lab course of two hours per week will supplement the theory. Implementation of basic and advanced algorithms will be done with C/C++. Basic knowledge of C/C++ programming is mandatory.

The course will involve four hours of contact including lectures, tutorials and lab classes. Students are strongly encouraged to participate actively in class discussions.

Course Outcomes (COs)

S No	Course outcomes	Level of Attainment
CO 1	To design interactive products that are usable, define key terms used in interaction design, explain key theories used in the design of interactive products.	Familiarity
CO 2	To explain the importance of iteration, evaluation, and prototyping in interaction design.	Usage
CO 3	To gather data in the context of developing a simple interactive product using suitable techniques, produce a low-fidelity prototype for an interactive product based upon a simple list of interaction design principles.	Usage
CO 4	To evaluate an interactive product using suitable techniques.	Usage
CO 5	To define a suitable program of user involvement that treats users ethically and fairly.	Usage

List of Experiments

S No	Topics	Hours
1	Getting familiar with Visual Studio Multiplication and Addition of any two numbers	**2**
2	Design an user interface for assigning a grade to students based on the subjects marks Design user interface for printing the numbers in Ascending order Descending order Subtraction	**2**
3	Design an user interface for calculator Design an user interface for registration of a student for admissions.	**2**
4	Design an user interface for semester registration Design an user interface for displaying and changing of a picture on the form Design an user interface for To count the number of digits in a given number	**2**
5	Design an user interface for simple sort program Design user interface	**2**
6	User interest form Making suggestion form	**2**
7	Design an user interface to check whether the year is a leap year or not Design an user interface for menu-based program	**2**
8	Design user Interfaces for ATM Machine Design user Interfaces for Socio E-commerce shop	**2**
9	Design user Interfaces for SmartPhone Design user Interfaces for Railway Reservation System	**4**
10	Design user Interfaces for Online Examination Design user Interfaces for Hospital management	**4**
11	Design user Interfaces for library management Design and User Interfaces for Hotel Booking	**4**
	Total Lab Hours	**28**

Evaluation Scheme:

S No	Exam	Coverage/Scope of Examination	Marks
1	Mid Term Test	Viva and Written Exam	20
2	End Term Test	Viva and Written Exam	20
3	Lab Records		15
4	Teacher Assessment	(Quality and quantity of experiment performed, learning laboratory skills)	30
5	Attendance and discipline in lab		15
6	Total		100

Reference Books:

- Interaction the BCS Specialist Group on Interaction
- The Usability Professionals' Association (UPA) - founded in the US, with local chapters in the US and other countries
- Mikael Ericsson's listing of research labs and projects worldwide
- Ubiquity - ACM online magazine (general IT topics, but lots relevant to HCI)
- Alan's column and resources on HCI Education in SIGCHI Bulletin
- HCI International has a bi-monthly subscription newsletter partly about the conference, but also carrying general news, events, etc. back issues at their Press Room
- Videos in User-System Interaction - collated by Matthias Rauterberg
- The HCI Bibliography - free-access online bibliographic database on Human-Computer Interaction
- HCI Resource Network - event listings, links, jobs, and subscription-only sections, includes A-Z of HCI topics
- Hans de Graaff's HCI Index
- Craig Marion's Software Design Smorgasbord
- Gary Perlman's Resources in HCI columns from Interactions
- University of Michigan HCI resource links
- The Usability First web site has good collections of resources, particularly for web and accessability
- Usability First glossary of usability terms

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

S No	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Avg
CO-1	3	3	3	2	2	3	1	1	2	1	1	3	2.1
CO-2	3	3	3	3	3	3	1	1	2	1	1	3	2.3
CO-3	3	3	3	3	3	3	1	1	2	1	1	3	2.3
CO-4	3	3	3	3	3	3	1	1	2	1	1	3	2.3
CO-5	3	3	3	3	3	3	1	1	2	1	1	3	2.3
CO-6	3	3	3	3	3	3	1	1	2	1	1	3	2.3
Avg	3	3	3	2.8	2.8	3	1	1	2	1	1	3	2.2

Cloud Computing: Concepts, Technology & Architecture

COURSE CODE: XXX **COURSE CREDITS:** 2 **CORE/ELECTIVE:** ELECTIVE **L-T-P:** 2-0-0

Pre-requisite: Knowledge of Computer Architecture, Computer Networking, and Distributed Computing.

Course Objectives:

1. To demonstrate an understanding of cloud computing concepts and standards.
2. To understand all enabling technologies of Cloud computing.
3. To discuss issues and challenges about the management of emerging cloud computing technologies and learn approaches to manage them.
4. To demonstrate the practical implementation and usage scenarios of Cloud computing.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	To learn the basic concepts, applications, and terminology of cloud computing.	Familiarity
CO-2	To learn basic concepts of infrastructure management and load balancing.	Familiarity
CO-3	To learn basic concepts of cloud security and metrics for evaluation.	Assessment
CO-4	To understand cloud computing and its role in new distributed computing implementation.	Assessment

Course Contents:

Unit	Contents	Lectures required
1	**Understanding Cloud Computing:** Basic Concepts and terminology, Goals and Benefits Risks and Challenges, Roles and boundaries, Cloud characteristics Cluster Computing, Grid Computing NIST Architecture, Cloud Deployment models Cloud service models	**4**
2	**Cloud Enabling Technologies:** Virtualization, Types of virtualization, Server Consolidation, virtualization management Web Technology Service-Oriented Architecture Datacenter and Multi-tenancy	**4**

3	**Cloud Infrastructure Management:** Cloud datacenter design, Workloads and software infrastructure for a datacenter Datacenter hardware, energy and power efficiency in a datacenter Cloud usage monitor, Monitoring agent, Resource agent, Polling Agent	**4**
4	**Cloud Mechanisms:** Automated Scaling Load Balancer SLA Monitor Failover System Multi-Cloud Broker	**5**
5	**Load Management:** Fundamental Cloud Architectures: workload distribution architecture, resource pooling architecture, dynamic scalability architecture, service load balancing architecture, cloud bursting architecture Billing Management System Business cost metrics, cloud usage cost metrics	**6**
6	**Metrics & security:** Cloud service metrics Cloud Security Mobile cloud computing Disaster recovery in cloud computing Case studies	**5**
	Total Lecture Hours	**28**

Suggested Text Book(s):

- Cloud Computing: Concepts, Technology & Architecture, by Zaigham Mahmood, Thomas Erl, Ricardo Puttini, Prentice-Hall, ISBN: 9780133387568.
- Cloud Computing Bible, by Barrie Sosinsky, Barrie Sosinsky.

Suggested Reference Book(s):

- Cloud Computing: A Practical Approach by Anthony T. Velte, Toby J. Velte, and Robert Elsenpeter; Tata McGraw – Hill Edition
- The Datacenter as a Computer – An Introduction to the Design of Warehouse Scale Machines by Luiz Andre Barroso and Urs Holzle; Morgan and Claypool Publishers
- Cloud Computing Explained: Implementation Handbook for Enterprises by John Rhoton
- The Cloud at Your Service by Jothy Rosenburg and Arthur Mateos.

Other useful resources (s):

- Link to NPTEL course contents: https://onlinecourses.nptel.ac.in/noc17_cs23/preview
- Link to topics related to course:
- **https://www.edx.org/learn/cloud-computing**

- **https://www.udemy.com/introduction-to-cloud-computing/**
    - **https://nptel.ac.in/courses/106104019/2 Evaluation Scheme**

S No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Tutorials / Assignments, Quizzes, Attendance	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs):

Course outcomes ((Cloud Computing: Concepts, Technology & Architecture)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	1.8
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	2
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	1.8
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	2.1
Average	2	2.5	2.5	2.5	2.5	1	1	1	2	2.3	1.5	2	1.9

Cloud Computing: Concepts, Technology & Architecture Lab

COURSE CODE: XXXXXXXX **COURSE CREDITS:** 1 **CORE/ELECTIVE:** ELECTIVE **L-T-P:** 0-0-2

Pre-requisite: Knowledge of Visualization, Web Service Architecture, Computer Architecture, Computer Networking, and Distributed Computing.

Course Objectives:

- To demonstrate various Visualization Platform.
- To demonstrate an understanding of cloud computing concepts and standards.
- To understand all enabling technologies for Cloud Deployment.
- To demonstrate the practical implementation and usage scenarios of Cloud computing.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO1	To learn the basic concepts, applications, and terminology of cloud computing.	Familiarity
CO2	To learn basic concepts of infrastructure management and load balancing.	Familiarity
CO3	To learn basic concepts of cloud security and metrics for evaluation.	Assessment
CO4	To understand cloud computing and its role in new distributed computing implementation.	Assessment

List of Experiments:

S No	Description	Hours
1	Introduction to Infrastructure as a Service Platforms like EC2 (AWS). Demonstrate the creation of a computing platform.	**2**
2	Demonstrate management and deployment for the IAAS platform by Remote Access platforms (Putty, remote desktop, etc).	**2**
3	Introduction to Visualization and its various types (Hypervisor type0 and type1).	**2**
4	Implementation of Visualization platforms (Sun Virtual Box, VM workstation, Zen, KVM) for Virtual Machine (VM) creation and management.	**4**
5	Implement and Management of various Virtual disk standards and VM imaging formats for Virtual Machine.	4
6	Implementation and installation of a Cloud management platform like	**4**

	open-stack / Eucalyptus etc.	
7	Creating a Warehouse Application in SalesForce.com.	4
8	Implementation and Deployment of a Platform as a Service Platform like Google App engine/ Microsoft azure etc.	**2**
9	Installation and Configuration of Hadoop.	**2**
10	Introduction to Cloud Simulation Platforms Like CloudSim and Green Cloud.	**2**
	Total Lab hours	**28**

Suggested Reference Books:

- Cloud Computing: Concepts, Technology & Architecture, by Zaigham Mahmood, Thomas Erl, Ricardo Puttini, Prentice-Hall, ISBN: 9780133387568.
- Cloud Computing Bible, by Barrie Sosinsky, Barrie Sosinsky.
- Cloud Computing: A Practical Approach by Anthony T. Velte, Toby J. Velte, and Robert Elsenpeter; Tata McGraw – Hill Edition
- The Datacenter as a Computer – An Introduction to the Design of Warehouse Scale Machines by Luiz Andre Barroso and Urs Holzle; Morgan and Claypool Publishers
- Cloud Computing Explained: Implementation Handbook for Enterprises by John Rhoton
- The Cloud at Your Service by Jothy Rosenburg and Arthur Mateos.
- Link to NPTEL course contents: https://onlinecourses.nptel.ac.in/noc17_cs23/preview
- Link to topics related to course:

a. https://www.edx.org/learn/cloud-computing
b. https://www.udemy.com/introduction-to-cloud-computing/
c. https://nptel.ac.in/courses/106104019/2Ev

Evaluation Scheme:

S No	Exam	Coverage/Scope of Examination	Marks
1	Mid Term Test	Viva and Written Exam	20
2	End Term Test	Viva and Written Exam	20
3	Lab Records		15
4	Teacher Assessment	(Quality and quantity of experiment performed, learning laboratory skills)	30
5	Attendance and discipline in lab		15
6	Total		100

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	Average
CO1	3	3	3	3	2	2	1	1	1	1	1	1	1.8
CO2	3	3	3	3	3	1	1	1	1	1	1	3	2
CO3	3	3	2	3	2	3	2	1	1	1	2	1	2
CO4	3	3	3	2	3	2	1	1	1	1	1	1	1.8
Average	3	3	2.8	2.8	2.5	2	1.3	1	1	1	1.3	1.5	1.9

Cloud Computing Security

COURSE CODE: XXXXXXXX **COURSE CREDITS:** 3 **CORE/ELECTIVE:** ELECTIVE **L-T-P:** 3-0-0

Pre-requisite: None

Course Objectives:

1. Understand some of the major security challenges of cloud computing that act as a hindrance to widespread adoption.
2. Learn about some of the newer techniques that scientists are considering toprotect cloud systems, their advantages, and disadvantages.
3. Learn how to critically evaluate security literature.
4. Learn how to formulate and solve a research problem in computer security and be able to present it.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	To understand the use of cloud computing	Familiarity
CO-2	A different technique to secure the cloud	Assessment
CO-3	Different types of attacks on the cloud.	Assessment
CO-4	Identify the known threats, risks, vulnerabilities and privacy issues associated with Cloud-based IT services	Usage

Course Contents:

Unit	Contents	Lectures required
1	Architectural and Technological Influences of Cloud Computing, Cloud deployment models Public, Private, Community and Hybrid models, Software as a Service (SaaS) Platform as a Service (PaaS) Infrastructure as a Service (IaaS), Cloud Computing Roles, Risks and Security Concerns	4
2	Guiding Security design principles for Cloud Computing, Secure Isolation, Comprehensive data protection, End-to-end access control, monitoring and auditing, Quick look at CSA, NIST and ENISA guidelines for Cloud Security, Common attack vectors and threats	6
3	**Secure Isolation**, Compute, Network and Storage, Common attack vectors and threats, Secure Isolation Strategies, Multitenancy, Virtualization strategies, Inter-tenant network segmentation	6

	strategies, Storage isolation strategies	
4	**Data Protection:** Understand the Cloud-based Information Life Cycle, Data protection for Confidentiality and Integrity, Common attack vectors and threats, Encryption, Data Redaction, Tokenization, Obfuscation, PKI and Key Management, Assuring data deletion, data retention, deletion and archiving procedures for tenant data, Data Protection Strategies	**6**
5	**Access Control for Cloud:** Understand the access control requirements for Cloud infrastructure, Common attack vectors and threats, Enforcing Access Control Strategies, Compute, Network and Storage, Authentication and Authorization, Roles-based Access Control, Multi-factor authentication, Host, storage and network access control options, OS Hardening and minimization, securing remote access, Verified and measured boot, Firewalls, IDS, IPS and honeypots	**6**
6	**Monitoring and auditing:** Proactive activity monitoring, Incident Response, Monitoring for unauthorized access, malicious traffic, abuse of system privileges, intrusion detection, events and alerts, Auditing – Record generation, Reporting, and Management, Tamper- proofing audit logs, Quality of Services, Secure Management, User management, Identity management, Security Information, and Event Management	**6**
7	**Identity Management in Cloud:** User Identification, Authentication, and Authorization in Cloud Infrastructure, Be able to understand the concepts of Identity & Access Management, Single Sign-on, Identity Federation, Identity providers and service consumers, The role of Identity provisioning	**4**
8	**Technology Review:** OpenStack Platform, Docker, Amazon Web Services	**4**
	Total Lecture Hours	**42**

Suggested Text Book(s):

- Cloud Computing Security: Foundations and Challenges John R. Vacca
- Cloud Security: A Comprehensive Guide to Secure Cloud Computing Ronald L Krutz, Russell Dean Vines

Suggested Reference Book(s):

- Securing The Cloud: Cloud Computing Security Techniques and Tactics by Vic (J.R.) Winkler
- Cloud Computing Design Patterns by Thomas Erl (Prentice Hall)

Other useful resources (s):

- http://www.cs.colostate.edu/~cs656/

Evaluation Scheme:

S No	Exam	Marks	Duration	verage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered up to T-1
2	T-2	25	1.5 Hours	Syllabus covered up to T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Cloud Computing Security)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	1.8
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	2
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	1.8
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	2.1
Average	2	2.5	2.5	2.5	2.5	1	1	1	2	2.3	1.5	2	1.9

Information Security

COURSE CODE: XXX
COURSE CREDITS: 2
CORE/ELECTIVE: Elective
: 2-0-0

Pre-requisite: None

Course Objectives:

1. Investigation of core security technologies and security policies to mitigate risks.
2. Gain an understanding of network perimeter security design principles
3. Gain an understanding of free/ commercial security tools and their applications and develop the security solution for a given application/scenario.
4. Ability to review procedures for installation, troubleshooting, and monitoring of network devices to maintain integrity, confidentiality, and availability of data and devices.
5. Knowledge of the technologies that underpin the deployment and maintenance of a secure network.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	Understand the need for security	Familiarity
CO-2	Analysis of security algorithms	Assessment
CO-3	Demonstrate familiarity with major security algorithms and data structure.	Assessment
CO-4	Apply important security algorithmic design paradigms and methods of analysis.	Usage

Course Contents:

Unit	Contents	Lectures required
1	**Symmetric Encryption** Shift Cipher, Substitution Cipher, Vigen`ere Cipher, A Permutation Cipher Introduction To Symmetric Ciphers, Stream Cipher Basics, The Lorenz Cipher, Linear Feedback Shift Registers, Combining LFSRs, RC4	5
2	Introduction To Block Ciphers, Feistel Ciphers and DES, Rijndael, Modes of Operation Key Management, Secret Key Distribution, Formal Approaches to Protocol Checking Hash Functions, Designing Hash Functions, Message Authentication Codes	5

3	**Public Key Encryption and Signatures** Public Key Cryptography Candidate One-way Functions, RSA, ElGamal Encryption, Rabin Encryption, Paillier Encryption Diffie–Hellman Key Exchange, Digital Signature Schemes, The Use of Hash Functions In Signature Schemes, The Digital Signature Algorithm, Schnorr Signatures, Nyberg–Rueppel Signatures	**5**
4	**Attacks on Public-Key Schemes** Wiener's Attack on RSA, Lattices and Lattice Reduction, Lattice-Based Attacks on RSA, Partial Key Exposure Attacks	**5**
5	**Provable Security:** Security of Signature Algorithms, Security of Encryption Algorithms, Hybrid Ciphers, Signature Schemes, Encryption Algorithms	**4**
6	**Advanced Protocols:** Access Structures, General Secret Sharing, Reed–Solomon Codes, Shamir Secret Sharing, Commitment Schemes, Oblivious Transfer, Showing a Graph Isomorphism in Zero-Knowledge, Zero-Knowledge and NP, Sigma Protocols	**4**
	Total Lecture Hours	**28**

Suggested Text Book(s):

- Cryptography: An Introduction, Nigel Smart
- Cryptography and Network Security: Principles and Practice William Stallings

Suggested Reference Book(s):

- A.J. Menezes, P. van Oorschot, and S.A. Vanstone. The Handbook of Applied Cryptography.

Evaluation Scheme:

S No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered up to T-1
2	T-2	25	1.5 Hours	Syllabus covered up to T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Information Security)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	1.8
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	2
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	1.8
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	2.1
Average	2	2.5	2.5	2.5	2.5	1	1	1	2	2.3	1.5	2	1.9

Information Security Lab

COURSE CODE: XXX **COURSE CREDITS:** 1 **CORE/ELECTIVE:** ELECTIVE **L-T-P:** 0-0-2

Pre-requisite: None

Course Objectives:

1. To understand the basic security algorithms
2. To Implement various symmetric cipher
3. To implement various public-key encryption algorithms

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO1	Understand the basic security services e.g. Authentication, Access Control, Confidentiality, Integrity	Familiarity
CO2	Learn standard symmetric encryption algorithms	Assessment
CO3	Learn architecture for public and private key cryptography.	Assessment
CO4	Learn the methods of digital signature and encryption.	Assessment
CO5	Learn key management and how key exchange protocols work.	Uses
CO6	Learn futuristic cryptographic techniques like Elliptic Curve and quantum cryptography	Assessment

List of Experiments

S No	Description	Hours
1	Study of Network Security fundamentals - Ethical Hacking, Social Engineering practices.	**2**
2	Study of System threat attacks - Denial of Services	**2**
3	Study of Sniffing and Spoofing attacks	**2**
4	Study of Techniques uses for Web-Based Password Capturing	**2**
5	Study of Different attacks causes by Virus and Trojans	**2**
6	Study of Anti-Intrusion Technique – Honey pot	**2**
7	Study of Symmetric Encryption Scheme – RC4	**4**
8	Implementation of S-DES algorithm for data encryption	**4**
9	Implementation of Asymmetric Encryption Scheme – RSA.	**4**
10	Study of IP based Authentication	**4**
	Total Lab hours	**28**

Suggested/Resources:

- Atual Kahate, " Cryptography and Network Security", TMH.
- William Stalling, " Cryptography and Network Security", Pearson.

Evaluation Scheme:

S No	Exam	Coverage/Scope of Examination	Marks
1	Mid Term Test	Viva and Written Exam	20
2	End Term Test	Viva and Written Exam	20
3	Lab Records		15
4	Teacher Assessment	(Quality and quantity of experiment performed, learning laboratory skills)	30
5	Attendance and discipline in lab		15
6	Total		100

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Avg
CO1	3	3	3	3	2	2	1	1	1	1	1	1	1.8
CO2	3	3	3	3	3	1	1	1	1	1	1	3	2
CO3	3	3	2	3	2	3	2	1	1	1	2	1	2
CO4	3	3	3	2	3	2	1	1	1	1	1	1	1.8
CO5	2	2	3	3	3	3	1	1	1	1	1	1	1.8
CO6	2	3	3	3	2	2	2	2	2	2	2	2	2.3
Avg	2.7	2.8	2.8	2.8	2.5	2.2	1.3	1.2	1.2	1.2	1.3	1.5	2

Game Development and Design

Course Name: Game Development and Design
Course Code: XXX
Course Credits: 2
CORE/ELECTIVE: ELECTIVE
Prerequisite: Knowledge of programming language (Python, C++,

Course Objective(s): To introduce students to the novel concepts of game development and design with special emphasis on its applications in diverse fields and current research.

Course Outcomes:

S No	Course outcomes	Level of Attainment
CO-1	Game Theory Introduction with Various Theorem	Familiarity
CO-2	Introduction of Nash Equilibrium, Bounded Rationality, Strategic Games, Strictly competitive Games	Assessment
CO-3	Methods to solve the Strategic Games with Matrix 2-person Games, 3-person Games	Assessment
CO-4	Introduction of Matrix Games & Linear Programming methods to solve complex Games	Assessment
CO-5	Design the games using by analyzing the Mixed Strategy Nash Equilibrium	Assessment
CO-6	Analysis of Game complexity by finite repeated & infinite repeated games	Assessment
CO-7	Design the Games with timeliness and restrict the strategies	Assessment
CO-8	Learn the games complexity by NASH FOLK Theorem	Usage
CO-9	Analyze the Game Design with best response & equality of pay-off	Usage

Course Contents:

Unit	Chapters	Lectures Required
1	**Introduction:** Game Theory, The theory of rational choice, Theory of Competitive Equilibrium, steady State and Deductive Interpretations, Bounded Rationality Terminology and Notation Nash Equilibrium- Strategic Games, Nash Equilibrium Examples Existence of a Nash Equilibrium, Strictly Competitive Games, Bayesian Games: Strategic Games with Imperfect Information	6
2	**Matrix Two-Person Games**(The Basics, The von Neumann Minimax Theorem, Mixed Strategies, Solving 2 × 2 Games Graphically, Graphical Solution of 2 × *m* and *n* × 2 Games, Best Response Strategies	4
3	**Solution Methods for Matrix Games:** Solution of Some Special	5

	Games, Invertible Matrix Games,Symmetric Games, Matrix Games and Linear Programming, Two-Person Nonzero Sum Games(The Basics, 2 × 2 Bimatrix Games, Best Response, Equality of Payoffs,	
4	**Mixed Strategy Nash Equilibrium** Interpretations of Mixed Strategy Nash Equilibrium Correlated Equilibrium Evolutionary Equilibrium Rationalizability and Iterated Elimination of Dominated Actions-Rationalizability Iterated Elimination of Strictly Dominated Actions, Iterated Elimination of Weakly Dominated Actions	**5**
5	**Repeated Games:** The Basic Idea Infinitely Repeated Games vs.\ Finitely Repeated Games Infinitely Repeated Games: Definitions Strategies as Machines Trigger Strategies: Nash Folk Theorems Punishing for a Limited Length of Time	**6**
6	**Game Examples:** 8 Queen Game, Sudoku Puzzle Game, Chess Board Game	**2**
	Total Lecture Hours	**28**

Text Book(s):

- Games Theory An Introduction second edition by E. N Barron Loyola University Chicago Chicago, Illinois

Reference Book(s):

- An Introduction to Game Theory by Martin J. Osborne
- Introduction to Game Theory by StefTijs Tilburg University Tilburg, HindustanBook Agency(India)
- Games of Strategy Theory And Application by Melvin Dresher Prentice – Hall, Inc. Englewood Cliffs, N.J.

Evaluation Scheme:

S No	Exam	Marks	Duration	verage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered up to T-1
2	T-2	25	1.5 Hours	Syllabus covered up to T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Tutorials / Assignments, Quizzes, Attendance	25	Entire Semester	Assignment - 9 Quizzes - 12 Attendance - 4

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

S No	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Avg
CO-1	3	2	3	1	2	3	3	2	1	2	2	2	2.2
CO-2	3	3	3	1	2	3	3	3	2	2	2	2	2.4
CO-3	3	3	3	1	2	3	2	3	2	2	3	3	2.5
CO-4	3	3	3	3	2	3	3	2	2	2	3	3	2.7
CO-5	3	3	3	2	2	3	3	3	2	2	3	3	2.7
CO-6	3	3	3	2	2	2	3	2	2	2	2	2	2.3
CO-7	3	3	3	2	2	2	2	2	2	2	3	2	2.3
CO-8	3	3	3	3	2	3	3	2	2	2	3	3	2.7
CO-9	3	3	3	3	2	3	3	3	2	2	3	2	2.7
Avg	3	2.9	3	2	2	2.8	2.8	2.4	1.9	2	2.7	2.4	2.5

Game Development Lab

COURSE CODE: XXX **COURSE CREDITS:** 1 **CORE/ELECTIVE:** ELECTIVE **L-T-P:** 0-0-2
Pre-requisite: Introduction to Computer Programming C ,C++, Matlab

Course Objectives:

1. To strengthen their problem-solving ability by applying logic & numerical approach.
2. To strengthen the ability to design and represent solutions to problems using Nash Equilibrium and saddle points.
3. To introduce the 2-Person, N-Person Game, Mixed Strategy, Convex Combination

Course Outcomes:

S.No.	Course outcomes	Level of Attainment
CO-1	To explain how the game is implemented through a matrix representation	Familiarity
CO-2	To analyze and decompose the problem into matrix & propose the various solutions using Nash Equilibrium, Mixed Strategy.	Assessment
CO-3	To design the game for 2-person, N-person e.g. Puzzle Game, Chess Board,8 Queen Game	Assessment

List of Experiments

S.No.	Description	Hours
1	There are 100 bankers lined up in each of 100 rows. Pick the richest banker in each row. Javier is the poorest of those. Pick the poorest banker in each column. Raoul is the richest of those. Who is richer: Javier or Raoul	**2**
2	Implement Mixed Strategy Problem & find out the expected payoff	**2**
3	Implement the Mixed strategy Problem and find the saddle point for finite & infinite user	**2**
4	Consider the game with matrix $\begin{bmatrix} 3 & -2 & 4 & 7 \\ -2 & 8 & 4 & 0 \end{bmatrix}$. Solve the game, find the best response for player1 to the strategy$(\frac{1}{4}, \frac{1}{2}, \frac{1}{8}, \frac{1}{8})$. What is 2nd best response to 1st best response?	**2**
5	Consider the game	**2**

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	$\begin{matrix}1 & -3 & -5 & 1\\ 0 & 4 & 4 & -2\\ 0 & 0 & 8 & 3\\ 0 & 0 & 0 & 50\end{matrix}$ Solve this game by finding v(A) and the optimal strategies.	
6	Consider the matrix for two-player $\begin{matrix}1,0 & 1,3 & 3,0\\ 0,2 & 0,1 & 3,0\\ 0,2 & 2,4 & 5,3\end{matrix}$ Find the Nash Equilibrium	**2**
7	Consider the matrix $\begin{matrix}1,1 & 3,x & 2,0\\ 2x,3 & 2,2 & 3,1\\ 2,1 & 1,x & x^2,4\end{matrix}$ Find x so that the game has exactly two pure Nash equilibrium?	**2**
8	Consider the game in which each player has two strategies Wait and Go. The game matrix is $\begin{bmatrix}1,1 & 1-€,2\\ 2,1-€ & 0,0\end{bmatrix}$ Find the correlated equilibria corresponding to the Nash equilibria 0<€<1	**2**
9	Implement the prisoner's dilemma game with matrix	**2**
10	The third column of the matrix $\begin{matrix}0 & 8 & 5\\ 8 & 4 & 6\\ 12 & -4 & 3\end{matrix}$ is dominated by a convex combination. Reduce the matrix and solve the game.	**2**
11	Use dominance to solve the following game even though it has no inverse $A = \begin{matrix}-4 & 2 & -1\\ -4 & 1 & 4\\ 0 & -1 & 5\end{matrix}$	**2**
12	Design the magic Square game. A Game has a matrix in which each row has a row sum that is the same as each of the column sums. For example $\begin{matrix}11 & 24 & 7 & 20 & 3\\ 4 & 12 & 25 & 8 & 16\end{matrix}$ $A = \begin{matrix}17 & 5 & 13 & 21 & 9\\ 10 & 18 & 1 & 14 & 22\\ 23 & 6 & 19 & 2 & 15\end{matrix}$	**2**
13	Design the 9×9 Sudoku puzzle game	**2**
14	Implement the chessboard for 2 users and find the optimal strategy	**2**
	Total Lab Hours	**28**

Evaluation Scheme:

S No	Exam	Coverage/Scope of Examination	Marks
1	Mid Term Test	Viva and Written Exam	20
2	End Term Test	Viva and Written Exam	20
3	Lab Records		15
4	Teacher Assessment	(Quality and quantity of experiment performed, learning laboratory skills)	30
5	Attendance and discipline in lab		15
6	Total		100

Reference Books

- An Introduction to Game Theory by Martin J. Osborne
- Introduction to Game Theory by Stef Tijs Tilburg University Tilburg, Hindustan Book Agency(India)
- Games of Strategy Theory and Application by Melvin Dresher Prentice – Hall, Inc. Englewood Cliffs, N.J.

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

CO/PO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	2	2	2	3	1	1	1	1	1	2	2	1.8
CO-2	3	3	3	3	3	2	1	2	2	1	2	3	2.3
CO-3	3	3	2	3	3	2	1	2	2	1	2	3	2.3
Average	3	2.8	2.5	2.8	3	1.8	1	1.8	1.8	1	2	2.8	

Information Auditing and Risk Management

Course Name: Information Auditing and Risk Management
Course Code: XXXXXX **Course Credits: 3-0-0 CORE/ELECTIVE:** ELECTIVE
Prerequisite: NIL

Course Objectives

- Targets project leaders involved in managing risk in capital projects.
- Providing a robust introduction of Enterprise Risk Management (ERM) and the ISO 31000 risk management standard.
- Exploring the practical processes involved in identifying, and evaluating internal and external risks to an organization.

Course Outcomes:

S No	Course outcomes	Level of Attainment
CO-1	To learn to explain why it is important to design interactive products that are usable, define key terms used in interaction design	Familiarity
CO-2	To learn to explain key theories used in the design of interactive products and to explain the importance of iteration, evaluation, and prototyping in interaction design	Familiarity
CO-3	To gather data in the context of developing a simple interactive product using suitable techniques	Assessment
CO-4	To produce a low-fidelity prototype for an interactive product based upon a simple list of interaction design principles and to evaluate an interactive product using suitable techniques	Assessment
CO-5	To communicate effectively to peers and specialists about requirements, design, and evaluation activities relating to interactive products	Usage
CO-6	To define a suitable program of user involvement that treats users ethically and fairly.	Usage

Course Contents:

Unit	Topic	Lectures Required
1	Introduction: Overview of course objectives and agenda, Interactive exercise – participants will complete a survey on the level of maturity of project risk management in their organization. Introduction to the Construction Industry Institute's Risk Management best practice area and its role in improving project performance	**4**
2	Risk Management Process: Introduction to risk management Owner and contractor perspectives on risk, The risk management process, Applying	**8**

	risk management throughout the project lifecycle, Roles and responsibilities	
3	Risk Identification: Major sources of risk, Risk identification methods – brainstorming, structured interviews, documentation review and risk checklists	**6**
4	Supporting tools: Risk Register template, Risk Breakdown Structure(RBS), Construction-focused Risk Checklist, Using the Risk Register template to document identified risks	**10**
5	Risk Assessment: The assessment process for identified risks, Selecting an appropriate risk assessment level for each project, Level 1 – Risk Identification, Level 2 – Probability & Impact	**4**
6	Utilizing the **Risk Assessment tables**, Recording assessment results in the Risk Register	**5**
7	Risk Response: Developing risk response plans and actions, Risk response strategies, Examples of "actionable" risk responses, Project contingency	**3**
8	Risk Monitoring: Tracking and reporting risks using the Risk Register, Monitoring existing risks and execution of risk response plans and actions, Integrating risk status into regular project communications and reporting	**2**
	Total Lecture Hours	**42**

Reference Books

- Risk Management, The Blackford Centre.
- Fundamentals of Risk Management: Understanding, Evaluating and Implementing Effective Risk Management
- Operational Risk Management: Best Practices in the Financial Services Industry

Evaluation Scheme:

S No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

CO/PO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	3	1	2	3	3	2	1	1	1	3	2.2
CO-2	3	2	1	2	1	1	2	3	2	1	1	3	1.8
CO-3	3	3	3	3	2	1	2	2	2	1	1	2	2.1
CO-4	3	3	2	3	2	1	2	3	2	1	1	2	2.1
CO-5	3	3	3	3	2	1	2	3	2	1	1	3	2.3
CO-6	3	3	3	3	2	1	2	3	2	1	1	3	2.3
Average	3	2.8	2.5	2.5	1.8	1.3	2.2	2.7	1.8	1	1	2.7	2.1

Information Modeling

COURSE CODE: XXX **COURSE CREDITS:** 3 **CORE/ELECTIVE:** ELECTIVE **L-T-P:** 3-0-0
Pre-requisite: Database systems, Data Mining

Course Objectives:

1. Learn to build an information modeling.
2. Learn the Concept of data and process modeling.
3. Learn the Concept of Component modeling.
4. Apply information modeling techniques to solve real-life problems.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	Understand the basics of information modeling application and their usages in different areas	Familiarity
CO-2	To be familiar with the basics of various modeling techniques	Familiarity
CO-3	Ability to apply modeling techniques on real-life scenarios to solve them easily	Assessment
CO-4	Ability to apply information modeling with Linked data	Usage

Course Contents:

Unit	Contents	Lectures Required
1	**Information Model:** Introduction, needs; Components of the information model. **Information Modeling:** Introduction: Why? What? How? Goals; Concepts; Information Modeling Vs Data Modeling.	8
2	**Data Modeling:** Introduction; Workflow of Data Modeling; Data Modeling Notations and Languages; Data Modeling Concepts; Challenges in Data Modeling.	6
3	**Meta Modeling:** Introduction; Concepts; Requirements on Metamodeling Notations; IRDS - Information Resource Dictionary Standard; Repositories; Introduction to Ontology; Analyzing and Comparing Ontologies with Meta-Models.	7
4	**Process Modeling:** Introduction; Workflow Management; Process Modeling; Workflow Management System; Executing Processes; Information Delivery Manuals and Model View Definitions.	6

5	**Data, Ontology, and Component Modelling:** A Taxonomic Class Modelling Methodology for Object-Oriented Analysis; Comprehension of Hierarchical ER Diagrams Compared to Flat ER Diagrams; Constraints on Conceptual Join Paths; A Service-Oriented Component Modelling Approach; Evaluation of Component-Based Development Methods.	**7**
6	**Information Modelling and Linked Data:** Introduction; Concepts of Linked Data and the Semantic Web; Technology: The Semantic Web Stack; Multiple Interlinked Models; Dynamic, Semantic Model Extensions; Querying and Reasoning	**8**
	Total Lecture Hours	**42**

Suggested Text Book(s):

- John Krogstie (SINTEF, Norway), Terry Halpin (Neumont University, USA), and Keng Siau (Missouri University of Science and Technology, USA): Information Modeling Methods and Methodologies: Advanced Topics in Database Research, IGI- Global, August 2004.
- André Borrmann, Markus K¨onig, Christian Koch, Jakob Beetz: Building Information Modeling, Springer,

Suggested Reference Book(s):

- Charrel, Pierre-Jean; Jaakkola, Hannu; Kangassalo, Hannu; Kawaguchi, Eiji: Information Modelling and Knowledge Bases, Frontiers in artificial intelligence and applications,

Evaluation Scheme:

S No	Exam	Marks	Duration	verage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered up to T-1
2	T-2	25	1.5 Hours	Syllabus covered up to T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	1	1	1	2	1	1	1	1	1	2	3	1.4
CO-2	3	1	1	2	2	1	1	1	1	1	2	3	1.6
CO-3	2	2	2	3	3	2	1	1	2	1	3	3	2.1
CO-4	3	2	3	3	3	2	1	1	1	1	3	3	2.2
Average	2.5	1.5	1.8	2.3	2.5	1.5	1	1	1.3	1	2.5	3	1.8

Ethics and Information Technology

COURSE CODE: XXX **COURSE CREDITS:** 3 **CORE/ELECTIVE:** ELECTIVE **L-T-P:** 3-0-0
Pre-requisite: None
Course Objectives:

1. The course will discuss the social impacts of computers in information technology.
2. Students will be given a broad overview of relevant topics to include free speech, privacy, security and the law
3. Understand the importance of ethical issues that emerge from the widespread use of information technology.
4. Professional and ethical responsibilities based on community values and the law will be discussed.
5. This course will focus on the economic, social, cultural, and global impacts of decisions that are made relating to information technology.
6. Understand the ethical issues associated with confidentiality and privacy as they relate to information technology.
7. Students will become familiar with organizations, laws, and regulations related to computer ethics and individual conduct in cyberspace.
8. Students will apply critical thinking skills to evaluate cyber ethics issues.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	Demonstrate knowledge of current models of information and computer ethics.	Familiarity
CO-2	Apply ethical theories to interpret personal and group behavior when using a variety of information technology tools.	Assessment
CO-3	Evaluate the nature of ethical choices made by self and others when serving various roles that expose social and multicultural differences.	Assessment
CO-4	Construct written arguments in a variety of formats on the evolving nature of ethical norms relating to new technologies	Usage

Course Contents:

Unit	Contents	Lectures required
1	**Introduction:** Defining key terms: Cyber ethics and Cyber technology, Four Developmental Phases in Cyber technology, Are Cyber ethics Issues Unique Ethical Issues? Digital Piracy, Cyber ethics as a Branch of	5

	Applied Ethics: Three Distinct Perspectives, A Comprehensive Strategy for Approaching Cyber ethics Issues, Ethics, and Morality.	
2	**Ethical Concepts and Critical Thinking:** Discussion of various scenarios: The "Runaway Trolley": A Classic Moral Dilemma, A Controversial Policy in America, A Dilemma Involving Conflicting Duties, Character-Based Ethical Theories, Integrating Aspects of Classical Ethical Theories into a Single Comprehensive Theory, Constructing an Argument: Valid Arguments, Sound Arguments, Invalid Arguments, Inductive Arguments, Fallacious Arguments, A Seven-Step Strategy for Evaluating arguments, Identifying some common fallacies.	**6**
3	**Professional Ethics and Privacy:** Professional Ethics, Safety-Critical Software, Professional Codes of Ethics and Codes of Conduct, Conflicts of Professional Responsibility: Employee Loyalty and Whistle-Blowing, Moral, Responsibility, Legal Liability, and Accountability, Risk Assessment in the Software Development Process, Do Some Computer Corporations Have Special Moral Obligations? **Privacy:** Personal privacy, Importance of Privacy, Gathering Personal Data: Monitoring, Recording, and Tracking Techniques Exchanging Personal Data: Merging and Matching Electronic Records, Mining Personal Data, Protecting Personal Privacy in Public Space, Privacy-Enhancing Technologies, Privacy Legislation, and Industry Self-Regulation.	**6**
4	**Security in Cyberspace:** Security in the context of cyber technology, Three categories of cybersecurity, Hacking, and "The Hacker Ethic, Cyberterrorism, Information Warfare(IW), Cybersecurity and Risk Analysis.	**5**
5	**Cyber Crime:** Cybercrimes and Cybercriminals, Hacking, Cracking, and Counterhacking, Defining Cybercrime, Three Categories of Cybercrime: Piracy, Trespass, and Vandalism in Cyberspace, Cyber-Related Crimes, Technologies and Tools for Combating Cybercrime, National and International Laws to Combat Cybercrime. Various scenarios: Virtual Casino, Prosecuting a Computer Corporation in Multiple Countries, The Pirate Bay Web Site, Are WikiLeaks' Practices Criminal? **Intellectual property:** What is Intellectual Property?Copyright law and Digital Media, Patents, Trademarks, and Trade Secrets, Jurisdictional Issues Involving Intellectual Property Law, Philosophical Foundations for Intellectual Property Rights, The Free Software and the Open Source Movements,	**8**
6	**Regulating Commerce:** Background Issues and Some Preliminary Distinctions, Four Modes of Regulation: The Lessing Model, Digital Rights Management and the Privatization of Information Policy, The Use and Misuse of (HTML) Metatags and Web Hyperlinks, Email-Spam, Free Speech vs. Censorship and Content Control in Cyberspace, "Network Neutrality" and the Future of Internet Regulation. algorithms.	**6**

7	**Community in CyberSpace:** Online Communities and Social Networking Services, Virtual Environments and Virtual Reality, Cyber Identities and Cyber Selves, AI, and its implications.	**4**
8	**Ethical aspects of emerging technologies:** Converging Technologies and Technological Convergence, Bioinformatics and Computational Genomics, Nanotechnology and Nano Computing, Autonomous Machines and Machine Ethics, A "Dynamic" Ethical Framework for Guiding Research in New and Emerging Technologies.	**2**
	Total Lecture Hours	**42**

Suggested Text Book(s):

- Tavani, H.T. (2010). Ethics and technology: Controversies, questions, and strategies in ethical computing (3rd ed.) Massachusetts, John Wiley & Sons Inc. [ISBN: 978-0- 470-50950-0].

Suggested Reference Book(s):

- Blackley, J. A., Peltier, J., & Peltier, T. (2003) Information Security Fundamentals, 1st ed. Boca Raton, FL. Auerbach Publications. [ISBN: 0849319579/9780849319570].

Evaluation Scheme:

S No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered up to T-1
2	T-2	25	1.5 Hours	Syllabus covered up to T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Ethics and Information Technology)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	**1.8**
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	**2**
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	**1.8**
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	**2.1**
Average	**2**	**2.5**	**2.5**	**2.5**	**2.5**	**1**	**1**	**1**	**2**	**2.3**	**1.5**	**2**	

Knowledge-Based AI: Cognitive Systems

COURSE CODE: XXX **COURSE CREDITS:** 3 **CORE/ELECTIVE:** ELECTIVE **L-T-P:** 3-0-0
Pre-requisite: Discrete Mathematics, Programming Languages

Course Objectives:
The course aims to familiarize the students with the basic concepts as well as with the state-of- the-art research literature in knowledge-based artificial intelligence. After successful completion of this course, students will be able to:

1. Understand concepts, methods, and prominent issues in knowledge-based artificial intelligence
2. Learn specific skills and abilities needed to apply those concepts to the design of knowledge-based AI agents
3. Understand the relationship between knowledge-based artificial intelligence and the study of human cognition.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	Understanding the basic concepts of knowledge-based AI & Cognitive Systems	Familiarity
CO-2	Understanding various fundamental concepts & techniques related to AI as well as cognitive systems.	Familiarity
CO-3	Learning & implementing various reasoning methods such as common sense reasoning, analogical reasoning, etc	Usage
CO-4	Designing & creating as well as metacognition knowledge	Assessment

Course Contents:

Unit	Contents	Lectures Required
1	**Introduction:** Introduction to KBAI & Cognitive Systems, Where Knowledge-Based AI fits into AI as a whole - Cognitive systems: what are they? - AI and cognition: how are they connected?	5
2	**Fundamentals:** Semantic Networks - Generate & Test - Means-Ends Analysis - Problem Reduction - Production Systems	5
3	**Common Sense Reasoning**: Frames - Understanding - Common Sense Reasoning - Scripts	4
4	**Planning & Learning:** Logic, Planning, Learning by Recording Cases - Incremental Concept Learning - Classification - Version	6

	Spaces & Discrimination Trees	
5	**Analogical Reasoning:** Case-Based Reasoning - Explanation-Based Learning - Analogical Reasoning	**5**
6	**Visuospatial Reasoning:** Constraint Propagation - Visuospatial Reasoning	**5**
7	**Design & Creativity:** Configuration - Diagnosis - Design - Creativity	**6**
8	**Metacognition:** Learning by Correcting Mistakes - Meta-Reasoning - AI Ethics	**6**
	Total Lecture Hours	**42**

Suggested Text Book(s):

- "Artificial Intelligence: A Modern Approach", Stuart Russell and Peter Norvig, 3rd Edition
- "Artificial Cognitive Systems: A Primer", David Vernon, 1st Edition

Suggested Reference Book(s):

- "Artificial Intelligence by Example", Denis Rothman

Other useful resources (s):

1. Link to NPTEL course contents:
   - https://nptel.ac.in/courses/106/105/106105077/
2. Link to topics related to course:
   - https://www.youtube.com/watch?v=0Alhb1HDsNw
   - https://www.youtube.com/watch?v=JMUxmLyrhSk
   - https://www.udacity.com/course/knowledge-based-ai-cognitive-systems--ud409

Evaluation Scheme:

S No	Exam	Marks	Duration	verage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered up to T-1
2	T-2	25	1.5 Hours	Syllabus covered up to T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Program Outcomes (POs)

Course outcomes (Knowledge-Based AI: Cognitive Systems)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	1.8
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	2
CO-3	2	2	3	3	3	1	1	1	2	2	1	2	1.9
CO-4	2	3	3	3	2	1	1	1	2	3	1	2	2
Average	2	2.5	2.8	2.8	2.5	1	1	1	2	2.3	1.3	2	1.9

Reinforcement Learning

COURSE CODE: XXX **COURSE CREDITS:** 3 **CORE/ELECTIVE:** ELECTIVE **L-T-P:** 3-0-0
Pre-requisite: Probability & Statistics, Machine Learning

Course Objectives:
The course aims to familiarize the students with the basic concepts as well as with the state-of- the-art research literature in deep reinforcement learning. After successful completion of this course, students will be able to:

1. Structure of a reinforcement learning problem
2. Understand and apply basic RL algorithms for simple sequential decision-making problems in uncertain conditions.
3. Evaluate the performance of the solution
4. Interpret state-of-the-art RL research and communicate their results.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	Understanding the basic concepts of Reinforcement Learning	Familiarity
CO-2	Understanding Probability Primer Techniques in detail.	Familiarity
CO-3	Learning & implementing various methods & techniques such as TD methods, Monte Carlo, Markov Decision Process, etc.	Usage
CO-4	Learning & understanding policy gradients along with its advantages and disadvantages.	Assessment

Course Contents:

Unit	Contents	Lectures Required
1	**Introduction:** Origin and history of Reinforcement Learning research. Its connections with other related fields and with different branches of machine learning.	2
2	**Probability Primer:** Axioms of probability, concepts of random variables, PMF, PDFs, CDFs, Expectation. Concepts of joint and multiple random variables, joint, conditional and marginal distributions. Correlation and independence.	4
3	**Markov Decision Process:** Introduction to RL terminology, Markov property, Markov chains, Markov reward process (MRP). Introduction to and proof of Bellman equations for MRPs along with proof of existence of solution to Bellman equations in MRP. Introduction to Markov decision	6

	process (MDP), state and action value functions, Bellman expectation equations, optimality of value functions and policies, Bellman optimality equations.	
4	**Prediction & Control by Dynamic Programming:** Overview of dynamic programming for MDP, definition and formulation of planning in MDPs, principle of optimality, iterative policy evaluation, policy iteration, value iteration, Banach fixed point theorem, proof of contraction mapping property of Bellman expectation and optimality operators, proof of convergence of policy evaluation and value iteration algorithms, DP extensions.	**6**
5	**Monte Carlo methods for Model Free Prediction & Control :** Overview of Monte Carlo methods for model free RL, First visit and every visit Monte Carlo, Monte Carlo control, On policy and off policy learning, Importance sampling.	**6**
6	**TD Methods:** Incremental Monte Carlo Methods for Model Free Prediction, Overview TD(0), TD(1) and TD(λ), k-step estimators, unified view of DP, MC and TD evaluation methods, TD Control methods - SARSA, Q-Learning and their variants.	**6**
7	**Function Approximation Methods:** Getting started with the function approximation methods, Revisiting risk minimization, gradient descent from Machine Learning, Gradient MC and Semi-gradient TD(0) algorithms, Eligibility trace for function approximation, After states, Control with function approximation, Least squares, Experience replay in deep Q-Networks.	**6**
8	**Policy Gradients:** Getting started with policy gradient methods, Log-derivative trick, Naive REINFORCE algorithm, bias and variance in Reinforcement Learning, Reducing variance in policy gradient estimates, baselines, advantage function, actor-critic methods.	**6**
	Total Lecture Hours	**42**

Suggested Text Book(s):

- "Reinforcement Learning: An Introduction", Richard S. Sutton and Andrew G. Barto, 2nd Edition
- "Probability, Statistics, and Random Processes for Electrical Engineering", 3rd Edition, Alberto Leon-Garcia

Suggested Reference Book(s):

- "Machine Learning: A Probabilistic Perspective", Kevin P. Murphy

Other useful resources (s):

1. Link to NPTEL course contents:
- https://nptel.ac.in/courses/106/106/106106143/
2. Link to topics related to course:

- https://www.youtube.com/watch?v=JgvyzIkgxF0
- https://www.youtube.com/watch?v=LzaWrmKL1Z4

Evaluation Scheme:

S. No	Exam	Marks	Duration	verage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered up to T-1
2	T-2	25	1.5 Hours	Syllabus covered up to T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Program Outcomes (POs)

Course outcomes (Reinforcement Learning)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	2	2	2	2	1	2	1.8
CO-2	2	3	3	3	3	1	3	2	2	2	1	2	2.3
CO-3	2	3	3	3	3	2	3	2	2	2	1	2	2.3
CO-4	2	3	3	3	2	1	2	3	2	3	2	2	2.3
Average	2	2.8	2.8	2.8	2.5	1.3	2.5	2.3	2	2.3	1.3	2	2.2

Architecting Distributed Cloud Applications

COURSE CODE: XXX **COURSE CREDITS:** 2 **CORE/ELECTIVE:** ELECTIVE **L-T-P:** 2-0-0
Pre-requisite: Cloud Computing, Distributed applications, Basic networking concepts.
Course Objectives:

1. To understand cloud distributed applications.
2. To know the benefits and challenges of microservices architecture.
3. To learn the fundamentals of service endpoints, scalability, and availability.
4. To know the fundamentals of messaging with queues.
5. To understand best practices for managing service configuration.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	Introduction to cloud computing and distributed cloud applications	Familiarity
CO-2	Network Communication in distributed cloud applications	Assessment
CO-3	Message Communication in distributed cloud applications	Assessment
CO-4	Versioning, upgrading, and configuration of distributed cloud applications	Usage

Course Contents:

Unit	Contents	Lectures Required
1	**Module 1:** **Cloud Computing Introduction:** Cloud computing definition, benefits of cloud computing. What are cloud applications, why develop cloud applications, what are orchestrators and containers in the cloud, the difference between orchestrators and containers? What are micro-services, why convert monolith applications to micro-services, micro-service architectural myths, auto-scaling of cloud microservices?	5
2	**Module 2: Network Communication** Network issues for distributed cloud applications, service endpoint scalability, and availability, forward and reverse proxies, cluster DNS, reverse proxy load balancers. What are service APIs for distributed cloud applications? Fault-tolerant network communication, circuit breaking.	4
3	**Module 3:Messiging Communication** What is message communication, benefits of message communication,	4

	messing with queues, fault-tolerant messaging process, some queue features?	
4	**Module 4: Versioning, upgrading, and configuration** Service update options, rolling updates feature, shutting down a service, gracefully shutting down a service, service configuration, and reconfiguration.	**4**
5	**Module 5: Leader Election** What is leader election, why we need leader, main roles, and responsibilities of a leader, leader election via lease, leader election via queue messages?	**5**
6	**Module 6: Storage Services** Introduction to data storage services, data temperature, object storage services, database storage services, backup restore, and disaster recovery.	**6**
	Total Lecture Hours	**28**

Suggested Text Book(s):

- Cloud Computing: Concepts, Technology & Architecture, by Zaigham Mahmood, Thomas Erl, Ricardo Puttini, Prentice-Hall, ISBN: 9780133387568
- Wilder, B. (2012). Cloud architecture patterns: using Microsoft azure. " O'Reilly Media, Inc.".

Suggested Reference Book(s):

- Srinivasan, V., Ravi, J., & Raj, J. (2018). Google Cloud Platform for Architects: Design and manage powerful cloud solutions. Packt Publishing Ltd.

Other useful resources (s):

This course is designed based on a famous course provided by Microsoft. Links to courses and content are as follows:

- https://courses.edx.org/courses/course- v1:Microsoft+DEVOPS200.9x+3T2019/course/
- https://azure.microsoft.com/en-in/blog/architecting-distributed-cloud-applications- free-video-course/
- https://www.youtube.com/watch?v=xJMbkZvuVO0&list=PL9XzOCngAkqs0Q8Z RdafnSYExKQurZrBY

EvaluationScheme:

S No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes(2) -10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Architecting Distributed Cloud Applications)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	2	1	1	1	1	1	1	1	1	1	1.4
CO-2	3	3	3	2	2	1	1	1	1	1	3	1	1.8
CO-3	3	3	3	2	2	2	1	1	1	1	3	1	1.9
CO-4	3	3	3	2	2	1	1	1	1	1	3	1	1.8
Average	3	3	2.8	1.8	1.8	1.3	1	1	1	1	2.5	1	1.8

Architecting Distributed Cloud Application Lab

COURSE CODE: XXXXX COURSE CREDITS: 1 **CORE/ELECTIVE:** ELECTIVE **L-T-P:** 0-0-2
Pre-requisite: Cloud Computing, Basic Networking

Course Objectives:

1. Learn to create a VM on the Microsoft Azure cloud.
2. Create Docker and install container on the docker.
3. Learn to run a network, communication, and storage services for cloud applications on containers.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO1	Install Docker and container. Deploy virtual machine on Microsoft Azure.	Familiarity
CO2	Create sample microservice on cloud container	Usage
CO3	Perform messaging service on cloud containers	Usage
CO4	Learn about storage service on cloud containers	Usage

List of Experiments

S No	Description	Hours
1	Deploy a Microsoft Azure Virtual Machine using free account. Create an account on Visual Studio Team Services (VSTS).	4
2	Install Docker on Ubuntu Machine.	4
3	Create a container image and run the container	4
4	Build a Sample Application with Microservices	4
5	Message Communication of Distributed Cloud Applications	4
6	Storage Services for Distributed Cloud Applications	4
7	Small Project using cloud application services	4
	Total Lab hours	**28**

Suggested/Resources:

This course is designed based on famous course provided by Microsoft. Links to courses and content are as follows:

- https://courses.edx.org/courses/course-v1:Microsoft+DEVOPS200.9x+3T2019/course/
- https://azure.microsoft.com/en-in/blog/architecting-distributed-cloud-applications-free- video-course/

- https://www.youtube.com/watch?v=xJMbkZvuVO0&list=PL9XzOCngAkqs0Q8ZRdaf nSYExKQurZrBY

Evaluation Scheme:

S No	Exam	Coverage/Scope of Examination	Marks
1	Mid Term Test	Viva and Written Exam	20
2	End Term Test	Viva and Written Exam	20
3	Lab Records		15
4	Teacher Assessment	(Quality and quantity of experiment performed, learning laboratory skills)	30
5	Attendance and discipline in lab		15
6	Total		100

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Average
CO1	3	3	2	1	1	1	1	1	1	1	1	1	1.4
CO2	3	3	3	2	2	1	1	1	1	1	3	1	1.8
CO3	3	3	3	2	2	2	1	1	1	1	3	1	1.9
CO4	3	3	3	2	2	1	1	1	1	1	3	1	1.8
Average	3	3	2.8	1.8	1.8	1.3	1	1	1	1	2.5	1	1.8

Optimization Methods in Business Analytics

COURSE CODE: XXX **COURSE CREDITS:** 3 **CORE/ELECTIVE:** ELECTIVE **L-T-P:** 3-0-0

Pre-requisite: Algorithm design

Course Objectives:

1. Learn the analytics of optimizing algorithms.
2. Learn various computing algorithms in solving complex problems.
3. Apply important algorithmic design paradigms and methods of analysis.
4. Synthesize efficient algorithm design in common engineering design situations.
5. Learn to analyze the specifications and sensitivity of the algorithms.
6. Learn the improvisations of algorithms.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	Comprehension of the design of the optimized algorithm.	Familiarity
CO-2	Demonstrate familiarity with major algorithms.	Assessment
CO-3	Analyze the different types of algorithms.	Assessment
CO-4	Apply algorithms for simulating the decision.	Usage

Course Contents:

Unit	Contents	Lectures Required
1	**Introduction to optimization technique:** Examples of optimization problems: Shortest path problem, integer knapsack; Unconstrained optimization; Unconstrained optimization; Convex set and Convex function; Duality: Geometric interpretation, Lagrangian Saddle point, Weak and strong duality.	8
2	**Linear programming:** Linear programming problem; Basic feasible solution; Geometric solution; Optimality condition and simplex method; Two-phase simplex method; Interior point method, Duality in linear programming, Karmarkars method.	8
3	**Transportation problem:** Characteristics of transportation problem; Northwest Corner Method; Least Cost Method; Vogel's Approximation Method **Assignment problem:** Characteristics of assignment problem, Hungarian methods, Dual of assignment problem, optimality of Hungarian methods.	6

4	**Integer programming:** Complexity of simplex methods**;** Elementary notions; Formulation; Solving 0-1 problem; Branch-Bound for integer programming; Cutting plane problem; All integer primal and Dual algorithm;	**8**
5	**Network models:** Characteristics of network models; Shortest path problem; Successive shortest path problem; Maximum flow problem; Minimum cost flow problem.	**6**
6	**Nonlinear programming:** Quadratic programming: Lagrange multiplier and KKT, Steepest descent method. **Sensitivity analysis:** dummy variable, linear programming, integer linear programming, nonlinear models and statistical test: t-test, chi- square test, Wilcoxon signed-rank	**6**
	Total Lecture Hours	**42**

Suggested Text Book(s):

- Singiresu S. Rao, Engineering Optimization: Theory and Practice by John Wiley and Sons, 4th edition, 2009.
- H. S. Kasane & K. D. Kumar, Introductory Operations Research, Springer (India), Pvt. Ltd., 2004
- Optimization for Engineering Design. K Deb.

Suggested Reference Book(s):

- Sheskin, David J. (2003) Handbook of Parametric and Nonparametric Statistical Procedures. CRC Press.
- Optimization concepts and applications in engineering, A. D. Belegundu and T. R. Chandrupatla.
- Linear and Nonlinear programming. Stephen G. Nash and A. sofer

Other useful resources (s):

- Link to NPTEL course contents: https://nptel.ac.in/courses/111/105/111105039/
- Link to NPTEL course contents: https://nptel.ac.in/courses/111/104/111104068/
- Link to NPTEL course contents: https://nptel.ac.in/courses/112/106/112106131/

Link to topics related to course:

- https://nptel.ac.in/courses/112/106/112106134/
- https://nptel.ac.in/courses/112/106/112106131/
- https://nptel.ac.in/courses/106104019/26
- https://nptel.ac.in/courses/111/105/111105039/

Evaluation Scheme:

S No	Exam	Marks	Duration	verage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Optimization Methods in Business Analytics)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	1.8
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	2
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	1.8
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	2.1
Average	2	2.5	2.5	2.5	2.5	1	1	1	2	2.3	1.5	2	1.9

From Graph to Knowledge Graph

COURSE CODE: XXX **COURSE CREDITS:** 2 **CORE/ELECTIVE:** ELECTIVE **L-T-P:** 2-0-0
Pre-requisite: Basic programming skills

Course Objectives:

1. You will learn graph representations.
2. Understand the entire process of how to design, construct, and query a knowledge graph to solve real-world problems.
3. Understand how to apply the tools and infrastructure to build and query knowledge graphs.
4. Use knowledge graphs in modern search applications.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	Learn graph representations	Familiarity
CO-2	Utilize fundamentals to build knowledge graphs	Assessment
CO-3	Understand the algorithms and techniques for crawling web sites, structured data extraction, and information extraction from unstructured text.	Assessment
CO-4	Understand how to apply the tools and infrastructure to build and query knowledge graphs.	Usage

Course Contents:

Unit	Contents	Lectures Required
1	Introduction and Overview Introduction to Graphs, Introduction to Knowledge graphs	**4**
2	Graph Properties and Applications: Graph basics, Graph Applications	**4**
3	Graph Representation Learning Embeddings and Graph Embeddings	**4**
4	Knowledge Graph (KG) - Fundamentals and Construction. KG Fundamentals How to Build a Knowledge Graph	**5**
5	Knowledge Graph (KG) - Inference and Applications KG Inference. How to Use a Knowledge Graph Why We Need Knowledge Graphs: Applications KG Applications	**6**
6	Knowledge graph analytics	**5**
	Total Lecture Hours	**28**

Suggested Text Book(s):

- Fensel, Dieter (et al.), "Knowledge Graphs Methodology, Tools and Selected Use Cases", Springer, 2020.
- Qi, G. et. al, "Knowledge Graph", Springer, 2020, ISBN 978-981-10-8177-4

Suggested Reference Book(s):

- Jeff Z. Pan, Guido Vetere, Jose Manuel Gomez-Perez, Honghan Wu, " Exploiting Linked Data and Knowledge Graphs in Large Organisations", Springer International Publishing, Print ISBN 978-3-319-45652-2, DOI https://doi.org/10.1007/978-3-319- 45654-6

- Mayank Kejriwal, "Domain-Specific Knowledge Graph Construction", Springer, DOI: 10.1007/978-3-030-12375-8

Other useful resources (s):

- Journal, "Knowledge-Based Systems", Springer

Evaluation Scheme:

S No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (From Graph to Knowledge Graph)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	1.8
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	2
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	1.8
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	2.1
Average	2	2.5	2.5	2.5	2.5	1	1	1	2	2.3	1.5	2	1.9

From Graph to Knowledge Graph Lab

COURSE CODE: XXX **COURSE CREDITS:** 1 **CORE/ELECTIVE:** ELECTIVE **L-T-P:** 0-0-2
Pre-requisite: Basic programming skills

Course Objectives:

1. The lab is designed to provide a versatile means to perform learning tasks over a knowledge graph.
2. Use Machine Learning over a Knowledge Graph

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO1	Build a knowledge graph from documents	Usage
CO2	Building a knowledge graph from a text	Usage
CO3	Build a Small Knowledge Graph	Usage
CO4	Understand the Graph Databases	Assessment
CO5	Familiarity with graph computing Frameworks	Familiarity
CO6	Able to Visualization of graphs	Assessment

List of Experiments

S No	Description	Hours
1	Introduction to Linked Data. Loan Prediction Practice Problem (Using Python) Build a knowledge graph from documents	4
2	Build a Small Knowledge Graph Creating and Processing Linked Data Building a knowledge graph from text A Knowledge Graph understanding and implementation	4
3	Build a Small Knowledge Graph Building a knowledge graph in python from scratch	4
4	Introduction to Graph Databases A Python Library for Knowledge Graph Embedding	6
5	Introduction to graph computing Frameworks	4
6	Introduction to Graph Visualization	6
	Total Lab hours	**28**

Suggested/Resources:

- Grakn KGLIB (Knowledge Graph Library) https://github.com/.
- Online resources.

- Fensel, Dieter (et al.), “Knowledge Graphs Methodology, Tools and Selected Use Cases”, Springer, 2020.

Evaluation Scheme:

S No	Exam	Coverage/Scope of Examination	Marks
1	Mid Term Test	Viva and Written Exam	20
2	End Term Test	Viva and Written Exam	20
3	Lab Records		15
4	Teacher Assessment	(Quality and quantity of experiment performed, learning laboratory skills)	30
5	Attendance and discipline in lab		15
6	Total		100

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Avg
CO1	3	3	3	3	2	2	1	1	1	1	1	1	**1.83**
CO2	3	3	3	3	3	1	1	1	1	1	1	3	**2.00**
CO3	3	3	2	3	2	3	2	1	1	1	2	1	**2.00**
CO4	3	3	3	2	3	2	1	1	1	1	1	1	**1.83**
CO5	2	2	3	3	3	3	1	1	1	1	1	1	**1.83**
C06	2	3	3	3	2	2	2	2	2	2	2	2	**2.25**
Avg	**2.67**	**2.83**	**2.80**	**2.80**	**2.60**	**2.20**	**1.20**	**1.00**	**1.00**	**1.00**	**1.20**	**1.40**	

Probabilistic Graphical Models

COURSE CODE: XXX **COURSE CREDITS:** 3 **CORE/ELECTIVE:** ELECTIVE **L-T-P:** 3-0-0
Pre-requisite: Machine learning and Probability

Course Objectives:

1. Learn introductory concepts in probabilistic graphical models.
2. Able to model problems using graphical models.
3. Able to model problems using design inference algorithms.
4. Learn the structure of the graphical model from data

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	Learn introductory concepts in probabilistic graphical models	Familiarity
CO-2	Able to model problems using graphical models.	Assessment
CO-3	Able to model problems using design inference algorithms.	Assessment
CO-4	Analyze the structure of the graphical model from data	Usage

Course Contents:

Unit	Contents	Lectures Required
1	**Fundamentals I**: Fundamentals of Probability Theory - Views of Probability, Random Variables and Joint Distributions, Conditional Probability, Conditional Independence, Expectation and Variance, Probability Distributions - Conjugate Priors, Introduction to Exponential Family;	3
2	**Fundamentals II**: Fundamentals of Graph Theory – Nodes and Edges, Paths and Trails, Cliques, Subgraphs, Cycles, and Loops.	3
3	**Graphical Models** I: Introduction - Directed Models (Bayesian Network), Undirected Models (Markov Random Fields), Dynamic Models (Hidden Markov Model & Kalman Filters) and Factor Graph;	6
4	**Graphical Models II**: Conditional Independence (Bayes Ball Theorem and D-separation), Markov Blanket, Factorization (Hammersley-Clifford Theorem), Equivalence (I-Maps & Perfect Maps); Factor Graphs - Representation, Relation to Bayesian Network and Markov Random Field.	6
5	**Inference in graphical models I**: Exact Inference - Variable Elimination, Elimination Orderings, Relation to Dynamic Programming, Dealing with Evidence, Forward-Backward Algorithm, Viterbi Algorithm; Junction Tree Algorithm; Belief Propagation (Sum-Product);	6

6	**Inference in graphical models I** I: Approximate Inference - Variational Methods (Mean Field, Kikuchi & Bethe Approximation), Expectation Propagation, Gaussian Belief Propagation; MAP Inference - Max-Product, Graph Cuts, Linear Programming Relaxations to MAP (Tree-Reweighted Belief Propagation, MPLP); Sampling - Markov Chain Monte Carlo, Metropolis Hastings, Gibbs (Collapsing & Blocking), Particle filtering	**6**
7	**Learning in Graphical Models I:** Overview, Parameter Estimation - Expectation Maximization, Maximum Likelihood Estimation, Maximum Entropy, Pseudolikelihood, Bayesian Estimation, Conditional Likelihood,	**6**
8	**Learning in Graphical Models II:** Structured Prediction; Learning with Approximate Inference; Learning with Latent Variables; Structure Learning, Structure Search, L1 priors.	**6**
	Total Lecture Hours	**42**

Suggested Text Book(s):

- Koller, D. and Friedman, N. (2009). Probabilistic Graphical Models: Principles and Techniques. MIT Press.

Suggested Reference Book(s):

- Jensen, F. V. and Nielsen, T. D. (2002). Bayesian Networks and Decision Graphs. Information Science and Statistics. Springer, 2nd edition.
- Kevin P. Murphy (2013) Machine Learning: A Probabilistic Perspective. 4th Printing. MIT Press.
- Barber, D. (2011). Bayesian Reasoning and Machine Learning. Cambridge University Press, 1st edition.
- Bishop, C. M. (2011). Pattern Recognition and Machine Learning(Information Science and Statistics). Springer, 2nd printing.
- Wainwright, M. and Jordan, M. (2008). Graphical Models, Exponential Families, and Variational Inference. Foundations and Trends in Machine Learning, 1:1–305.

Other useful resource(s):

- Conference papers and journal articles

Evaluation Scheme:

S No	Exam	Marks	Duration	verage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Probabilistic Graphical Models)	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**Average**
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	**1.75**
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	**2**
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	**1.75**
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	**2.08**
Average	**2**	**2.5**	**2.5**	**2.5**	**2.5**	**1**	**1**	**1**	**2**	**2.25**	**1.5**	**2**	1.89

Image Analysis and Pattern Recognition

COURSE CODE: XXX **COURSE CREDITS:** 2 **CORE/ELECTIVE:** ELECTIVE **L-T-P:** 2-0-0

Pre-requisites: Linear algebra, Matrices, Matrix Operations, Determinants, Systems of Linear Equations, Eigenvalues, Eigenvectors, Statistics and probability, Programming experience, preferably in MATLAB, and/or C/C++/C#/Python/Java

Course Objective:
The course aims to introduce the student to various image processing techniques. The student learns about image fundamentals, describes the main characteristics of digital images, how they are represented, mathematical transforms such as Fourier, Cosine transforms, Singular value decomposition, 2D Wavelet transform, image enhancement techniques, Image restoration and denoising, segmentation, lossy and lossless data compression algorithms, binary and color image processing. The student will be exposed to dealing with image data through programming assignments using MatLab, and/or C/C++/C#/Python/Java.

Course Outcome:
Upon completion of this course, a successful student should be able to design and implement programs that deal with image data.

- To understand how digital images are represented, manipulated, encoded, and processed, with emphasis on algorithm design, implementation, and performance evaluation.
- Emphasis will be to develop engineering skills and intuitive understanding of the tools used in Image Processing.
- The students would be encouraged to design and develop the image processing algorithms/tools for real-life problems.

Course Outcomes:

S No	Course outcomes	Level of Attainment
CO-1	To understand the different images and their processing	Familiarity
CO-2	To understand the concept of Image transformation Algorithms/techniques	Assessment
CO-3	To understand the concepts of lossy and Lossless compression Algorithms/techniques	Assessment
CO-4	To understand the concepts of Image enhancement and Segmentation Algorithms/techniques	Assessment
CO-5	To understand the concepts of Image Restoration and Denoising Algorithms/techniques	echnical skills
CO-6	To understand the concepts of Binary and Color image processing	Assessment

CO-7	To understand the concepts of Object recognition decision-theoretic methods and structural methods	chnical skills

Course contents:

Unit	Topic	Lectures required
1	**Introduction to Digital Image Processing** Introduction to images and its processing, Components of image processing systems, image representations, Image file formats, Applications of digital image processing, image sampling, and quantization, Image Analysis, Intensity transformations, contrast stretching, Correlation, and convolution, Smoothing filters, sharpening filters, gradient, and Laplacian.	3
2	**Image Transformation Techniques** Need for transform, Fourier, Cosine transforms, Haar, KL Transform, Singular value decomposition, 2D Wavelet transform, Different properties of image transform techniques.	4
3	**Image Compression Basics** Concept of image compression, lossless techniques (Huffman Coding, Arithmetic, and Lempel-Ziv Coding, Other Coding Techniques) and lossy compression techniques (Transform Coding & K-L Transforms, Discrete Cosine Transforms, and BTC), Multi-Resolution Analysis, and Still Image Compression Standards (JBIG and JPEG),	4
4	**Image Enhancement** **Enhancement in spatial and transform domain,** histogram equalization DirectionalSmoothing, Median, Geometric mean, Harmonic mean, Contrahar monic mean filters, Homomorphic filtering, Color image enhancement.	3
5	**Image Restoration and Denoising** Image degradation, Type of image blur, Classification of image restoration techniques, image restoration model, Linear, and non-linear restoration techniques, Image denoising, Median filtering	3
6	**Image Segmentation** **Classification of image segmentation techniques,** Boundary detection based techniques, Point, line detection, Edge detection, Edge linking, local processing, regional processing, Hough transform, Thresholding, Iterative thresholding, Otsu's method, Moving averages, Multivariable thresholding, Region-based segmentation, Watershed algorithm, Use of motion in segmentation	4
7	**Binary and Color image processing** Binarization, Basic Set theory, Binary morphological operations, and its properties, Color Image Representation in MATLAB, Converting Between Color Spaces, The Basics of Color Image Processing, Color Transformations, Spatial Filtering of Color Images, Working Directly in RGB Vector Space	3
8	**Object Recognition** **Decision theoretic methods:** Matching, Optimal statistical Classifier, Neural network.	4

	Structural methods: Matching shape numbers, String matching, Syntactic recognition of string, Syntactic recognition of tree.	
	Total Lecture Hours	**28**

Recommended Books

- Digital Image Processing, R.C. Gonzalez and R.E. Woods, 2nd edition, Pearson Prentice Hall, 2008
- Anil K. Jain, *Fundamentals of Digital Image Processing*, Prentice-Hall, 1989.
- Digital Image processing, S Jayaraman, TMH, 2012
- William K. Pratt, *Digital Image Processing*, 3rd Edition, John Wiley, 2001.

Evaluation Scheme:

S No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Avg
CO1	3	3	3	2	3	3	2	2	2	2	2	3	2.5
CO2	3	3	3	2	2	2	2	2	2	2	2	3	2.3
CO3	3	3	3	2	3	2	2	2	2	2	2	3	2.4
CO4	3	3	3	2	3	2	2	2	2	2	2	3	2.4
CO5	3	3	3	2	3	2	2	2	2	2	2	3	2.4
CO6	3	3	3	2	3	2	2	2	2	2	2	3	2.4
CO7	3	3	3	3	3	3	2	2	3	2	3	3	2.8
Avg	3	3	3	2.1	2.9	2.3	2	2	2.1	2	2.1	3	2.5

Image Analysis and Pattern Recognition Lab

COURSE CODE: XXX **COURSE CREDITS:** 1 **CORE/ELECTIVE:** ELECTIVE L-T-P: 0-0-2

Pre-requisite: programming, algorithm, matrix operations

Course Objectives: In this lab, you will implement image processing techniques that you will learn during the frontal course. Work in the lab will be carried out in Matlab and OpenCV

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO1	Introduction to basic image processing operations and histogram algorithms	Familiarity
CO2	Introduction to image filtering in spatial and in frequency domains.	Assessment
CO3	Introduction to image restoration.	Assessment
CO4	Introduction of principles of the JPEG baseline coding system.	Assessment
CO5	Getting familiar with the OpenCV library. Basic processing of color images and introduction to video tracking using the Camshaft algorithm.	chnical skills
CO6	Analyze the systems using Laplace transform and Z-transform.	Assessment

List of Experiments

S No	Description	Hours
1	Introduction to MATLAB. In this lab, we will study basic image-processing operations: image resizing and rotation, quantization, and histogram algorithms. We will analyze the effects of resizing and quantization on image quality and the methods to improve the quality and avoid artifacts. Histogram techniques allow us to analyze the distribution of gray levels in an image. In this lab, we will study histogram, histogram normalization, and histogram equalization. Understand the basics of MATLAB syntax, functions, and programming.	4
2	In this lab, we'll study the properties of DFT and two practical applications: 1. Computation of convolution by two methods – direct method (in the spatial domain) and indirect method (in the frequency domain). 2.Computation of edge enhancement by unsharp masking.	4
3	In practical imaging systems, the acquired image often suffers from the effects of blurring and noise. Image restoration algorithms are aimed to restore the original undistorted image from its blurry and noisy version. The lab experiment demonstrates the evolution of restoration algorithms from the simple Inverse Filter, Pseudo Inverse Filter, and Wiener Filter	4
	Mid sem exam	2

4	In this lab, we will present the basic concepts used for JPEG coding and experiment with different coding parameters. The JPEG standard provides a powerful compression tool used worldwide for different applications. This standard has been adopted as the leading lossy compression standard for natural images due to its excellent compression capabilities and its configurability.	**4**
5	OpenCV is an open-source computer vision library, written in C and C++. One of the main goals of OpenCV is to provide a simple-to-use computer vision infrastructure that helps people to build sophisticated vision applications quickly. Among the tools provided by OpenCV are image transformations, histograms, video tracking, 3D vision algorithms, and machine learning.	**4**
6	Implementation of Camshaft algorithm, Mean-shift algorithm and Adaptive adjustment	**4**
	End-semester Exam	**2**
	Total Lab hours	**28**

Suggested/Resources:

- R. C. Gonzalez, R. E. Woods and S. L. Eddins, *Digital Image Processing using MATLAB*. Pearson Education, Inc., 2004 (Library Dewey number 621.368 GON).
- OpenCV library: http://SourceForge.net/projects/opencvlibrary

Evaluation Scheme:

S No	Exam	Coverage/Scope of Examination	Marks
1	Mid Term Test	Viva and Written Exam	20
2	End Term Test	Viva and Written Exam	20
3	Lab Records		15
4	Teacher Assessment	(Quality and quantity of experiment performed, learning laboratory skills)	30
5	Attendance and discipline in lab		15
6	Total		100

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Avg
CO1	3	3	3	3	2	2	1	1	1	1	1	1	1.8
CO2	3	3	3	3	3	1	1	1	1	1	1	3	2
CO3	3	3	2	3	2	3	2	1	1	1	2	1	2
CO4	3	3	3	2	3	2	1	1	1	1	1	1	1.8
CO5	2	2	3	3	3	3	1	1	1	1	1	1	1.8
CO6	2	3	3	3	2	2	2	2	2	2	2	2	2.3
Avg	2.7	2.8	2.8	2.8	2.5	2.2	1.3	1.2	1.2	1.2	1.3	1.5	2

Statistics and Exploratory Data Analytics

COURSE CODE: XXX **COURSE CREDITS:** 2 **CORE/ELECTIVE:** ELECTIVE **L-T-P:** 2-0-0
Pre-requisite: None

Course Objectives:

1. Learn the basic concept of statistics and exploratory data analysis.
2. Learn graphical and modeling techniques for exploring data.
3. Learn Data Transformation and dimensionality reduction of data.
4. Learn data clustering and scatter plots.
5. Apply exploratory data analysis techniques to visualized data.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	Analyze the concept of statistics and exploratory data analysis.	Familiarity
CO-2	Graphical and modeling techniques for exploring data.	Assessment
CO-3	Implement data transformation, dimensionality reduction	Assessment
CO-4	Apply data clustering and visualized exploratory data through various plots and graphs.	Usage

Course Contents:

Unit	Contents	Lectures required
1	**Concept of statistics and exploratory data analysis:** Introduction of data and its types (categorical and quantitative), Central Tendency: mean, median, mode, variance, standard deviation, skewness, kurtosis, exploratory data analysis, and its types, data dimensionality.	5
2	**Graphical and modeling techniques for exploratory data:** Box Plot, Histogram, Multi-Vari Chart, Run Chart, Pareto Chart, Scatter Plot, Stem-and-leaf plot.	5
3	**Data transformation, dimensionality reduction**: Power transformation, standardization, multidimensional scaling, principal component analysis, linear or non-linear dimensionality reduction.	7
4	**Data Clustering Techniques:** Data clustering, Hierarchal methods, optimization method, k-means, and model-based clustering.	5
5	**Smoothing scatter plots and graphical methods for EDA:** Bivariate distribution smooths, curve fitting toolbox, Dendrogram, treemaps, rectangle plots.	6
	Total Lecture Hours	28

Suggested Text Book(s):

- Martinez, W. L.; Martinez, A. R. & Solka, J. (2010). *Exploratory Data Analysis with MATLAB, second edition*. Chapman & Hall/CRC.
- Hoaglin, D C; Mosteller, F & Tukey, John Wilder (Eds) (1983). *Understanding Robust and Exploratory Data Analysis.*
- Andrienko, N & Andrienko, G (2005) *Exploratory Analysis of Spatial and Temporal Data. A Systematic Approach*

Suggested Reference Book(s):

- Tukey, John Wilder (1977). *Exploratory Data Analysis*. Addison-Wesley

Evaluation Scheme:

S No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Statistics and Exploratory Data Analytics)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	1.8
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	2
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	1.8
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	2.1
Average	2	2.5	2.5	2.5	2.5	1	1	1	2	2.3	1.5	2	1.9

Statistics and Exploratory data analytics Lab

COURSE CODE: XXX **COURSE CREDITS:** 1 **CORE/ELECTIVE:** ELECTIVE **L-T-P:** 0-0-2
Pre-requisite: Basic knowledge of python programming and Matlab.

Course Objectives:

1. Learn to explore a dataset
2. Visualization of data
3. Dimensionality reduction of data
4. Cluster findings in a dataset
5. Usage of curve fitting tools

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO1	Understand the basics of MATLAB syntax/python libraries	Familiarity
CO2	Exploring dataset and visualizing data on different charts.	Assessment
CO3	Perform the basic operations of data pre-processing and dimensionality reduction.	Assessment
CO4	Design and analyze clustering techniques.	Usage
CO5	Understanding of curve fitting toolbox.	Usage
CO6	Implementation of dendrogram and treemaps.	Usage

List of Experiments

S No	Description	Hours
1	Introduction to MATLAB/Python Libraries	**2**
2	Exploring dataset and data preprocessing	**2**
3	Importing dataset in python	**2**
4	Implementation of standard deviation and skewness of data	**2**
5	Visualizing data on a histogram	**2**
6	Implementations of the box plot chart	**2**
7	Implementation of data representation in the pie chart	**2**
8	Implementation of data representation in scatter plot	**2**
9	Implementation of a column chart	**2**
10	Implementation of principal component analysis techniques	**2**
11	Implementation of nonlinear dimensionality reduction	**2**
12	Finding cluster in a dataset	**2**
13	Implementation of hierarchal clustering techniques	**2**
14	Implementation of curve fitting toolbox	**2**
	Total Lab hours	**28**

Suggested/Resources:

- Martinez, W. L.; Martinez, A. R. & Solka, J. (2010). *Exploratory Data Analysis with MATLAB, second edition*. Chapman & Hall/CRC.
- Hoaglin, D C; Mosteller, F & Tukey, John Wilder (Eds) (1983). *Understanding Robust and Exploratory Data Analysis.*

Evaluation Scheme:

S No	Exam	Coverage/Scope of Examination	Marks
1	Mid Term Test	Viva and Written Exam	20
2	End Term Test	Viva and Written Exam	20
3	Lab Records		15
4	Teacher Assessment	(Quality and quantity of experiment performed, learning laboratory skills)	30
5	Attendance and discipline in lab		15
6	Total		100

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Avg
CO1	3	3	3	3	2	2	1	1	1	1	1	1	**1.83**
CO2	3	3	3	3	3	1	1	1	1	1	1	3	**2.00**
CO3	3	3	2	3	2	3	2	1	1	1	2	1	**2.00**
CO4	3	3	3	2	3	2	1	1	1	1	1	1	**1.83**
CO5	2	2	3	3	3	3	1	1	1	1	1	1	**1.83**
C06	2	3	3	3	2	2	2	2	2	2	2	2	**2.25**
Avg	**2.67**	**2.83**	**2.80**	**2.80**	**2.60**	**2.20**	**1.20**	**1.00**	**1.00**	**1.00**	**1.20**	**1.40**	

Information Visualization

COURSE CODE: XXX **COURSE CREDITS:** 3 **CORE/ELECTIVE:** ELECTIVE **L-T-P:** 3-0-0
Pre-requisite: Basic mathematics courses

Course Objectives:

1. Information visualization offers instruments for reasoning about quantitative information, analyzing, and communicating statistical information.
2. The course overviews the main typologies of data graphics (data-maps, time-series, space-time narrative, relational diagrams, graphs and methods for dimensionality reduction)
3. The course provides a language for discussing data visualizations combined with knowledge of the human perception of visual objects.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	Big Data and Large-Scale Computation, Web Technologies	Familiarity
CO-2	Applications and Science, Signal Processing and Data Science tracks	Assessment
CO-3	Game Design and Production and Machine Learning, Data Science and Artificial Intelligence majors	Assessment
CO-4	Machine Learning, Data Science and Artificial Intelligence, Analytics and Data Science minor.	Usage
CO-5	ICT Innovation program's Data Science, Digital Media Technology, Human-Computer Interaction minor, and Life Science Technologies Complex Systems major and minor and Bioinformatics and Digital Health minor.	Usage

Course Contents:

Unit	Contents	Lectures required
1	**Foundations for an Applied Science of Data Visualization:** Visualization Stages, Experimental Semiotics Based on Perception, Semiotics of Graphics, Sensory versus Arbitrary Symbols, Gibson's Affordance Theory, A Model of Perceptual Processing, Costs and Benefits of Visualization, Types of Data, Metadata	6
2	**The Environment, Optics, Resolution, and the Display:** The Environment, The Eye, The Optimal Display	4
3	**Lightness, Brightness, Contrast, and Constancy:** Neurons, Receptive Fields, and Brightness Illusions, Luminance, Brightness, Lightness, and	4

	Gamma, Perception of Surface Lightness, Monitor Illumination and Monitor Surrounds	
4	**Color:** Trichromacy Theory, Color Measurement, Opponent Process Theory, Properties of Color Channels, Color Appearance, Applications of Color in Visualization	**4**
5	**Visual Salience and Finding Information:** Eye Movements, V1, Channels, and Tuned Receptors, Preattentive Processing and Ease of Search, Integral and Separable Dimensions: Glyph Design, Representing Quantity, The Searchlight Metaphor and Cortical Magnification	**6**
6	**Static and Moving Patterns:** Gestalt Laws, Texture: Theory and Data Mapping, Perception of Transparency: Overlapping Data, Perceiving Patterns in Multidimensional Discrete Data, Pattern Learning, The Visual Grammar of Node–Link Diagrams, The Visual Grammar of Maps, Patterns in Motion, Perception of Animated Motion, The Processes of Pattern Finding	**6**
7	**Space Perception:** Depth Cue Theory, Depth Cues in Combination, Task-Based Space Perception, Tracing Data Paths in 3D Graphs, Judging the Morphology of Surfaces, Patterns of Points in 3D Space, Perceiving Patterns in 3D Trajectories, Judging Relative Positions of Objects in Space, Judging the Relative Movements of Self within the Environment, Selecting and Positioning Objects in 3D, Judging the "Up" Direction, The Aesthetic Impression of 3D Space (Presence)	**6**
8	**Visual Objects and Data Objects:** Image-Based Object Recognition, Structure-Based Object Recognition, The Object Display, and Object-Based Diagrams, Faces, Coding Words and Images, Labels and Concepts, Concept Mapping, Iconic Images versus Words versus Abstract Symbols, Scenes and Scene Gist	**6**
Total lectures		**42**

Suggested Text Book(s):

- Ware, C., 2020. Information visualization: perception for design. Morgan Kaufmann.

Suggested Reference Book(s):

- Bederson, B.B., Bederson, B.B., and Shneiderman, B. eds., 2003. The craft of information visualization: readings and reflections. Morgan Kaufmann.
- Bergman, E. ed., 2000. Information appliances and beyond: interaction design for consumer products. Morgan Kaufmann.

Other useful resources (s):

- https://www.youtube.com/watch?v=t0B2sxIumh0&list=PLk_jmmkw5S2C1A_ZD3mp Bb3Og_Y1QZ83Z
- https://www.youtube.com/watch?v=IKSRwGZe8Oc

Evaluation Scheme:

S No	Exam	Marks	Duration	verage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes(2) -10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Information Visualization)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	1.8
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	2
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	1.8
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	2.1
CO-5	2	3	3	3	2	1	1	1	2	3	2	2	2.1
Average	2	2.6	2.6	2.6	2.4	1	1	1	2	2.4	1.6	2	

Introduction to Deep Learning

COURSE CODE: XXX **COURSE CREDITS:** 3 **CORE/ELECTIVE:** ELECTIVE **L-T-P:** 3-0-0

Pre-requisite:

1) Basic knowledge of Python.
2) Basic linear algebra and probability.

Course Objectives:

1. The goal of this course is to give learners a basic understanding of modern neural networks and their applications in computer vision and natural language understanding.
2. The course starts with a recap of linear models and discussion of stochastic optimization methods that are crucial for training deep neural networks.
3. Learners will study all popular building blocks of neural networks including fully connected layers, convolutional and recurrent layers.
4. Learners will use these building blocks to define complex modern architectures in TensorFlow and Keras frameworks.
5. In the course, project learner will implement a deep neural network for the task of image captioning which solves the problem of giving a text description for an input image.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	Linear regression: mean squared error, analytical solution.	Familiarity
CO-2	Logistic regression: model, cross-entropy loss, class probability estimation	Assessment
CO-3	Gradient descent for linear models. Derivatives of MSE and cross-entropy loss functions.	Assessment
CO-4	The problem of overfitting.	Usage
CO-5	Regularization for linear models.	Usage

Course Contents:

Unit	Contents	Lectures Required
1	**Introduction to optimization:** Linear regression, Linear classification Gradient descent, Overfitting problem and model validation, Model regularization, Stochastic gradient descent, Gradient descent extensions9m	**8**

2	**Introduction to neural networks:** Multilayer perceptron (MLP), Chain rule, Backpropagation, Efficient MLP implementation, Other matrix derivatives, what is TensorFlow, our first model in TensorFlow, What Deep Learning is and is not, Deep learning as a language	**8**
3	**Deep Learning for images:** Motivation for convolutional layers11m Our first CNN architecture, Training tips and tricks for deep CNNs, Overview of modern CNN architectures, Learning new tasks with pre-trained CNNs, A glimpse of other Computer Vision tasks8m	**6**
4	**Unsupervised representation learning:** Unsupervised learning: what it is and why bother, Autoencoders 10, Autoencoder applications, Autoencoder applications: image generation, data visualization & more, Natural language processing primer, Word embeddings, Generative models 10, Generative Adversarial Networks, Applications of adversarial approach	**6**
5	**Deep learning for sequences:** Motivation for recurrent layers, Simple RNN and Backpropagation, The training of RNNs is not that easy, Dealing with vanishing and exploding gradients, Modern RNNs: LSTM and GRU, Practical use cases for RNNs	**8**
6	**Final Project:** This week you will apply all your knowledge about neural networks for images and texts for the final project. You will solve the task of generating descriptions for real-world images!	**6**
	Total Lecture Hours	**42**

Suggested Text Book(s):

Ian Goodfellow, YoshuaBengio, and Aaron Courville, "Deep Learning", The MIT Press, Cambridge, 2016.

- Charu C. Aggarwal, "Neural Networks and Deep Learning: A Textbook", Springer, 2018.

Suggested Reference Book(s):

- Josh Patterson, Adam Gibson, "Deep Learning: A Practitioner's Approach", 2nd Edition, OReilly Media
- Andrew Ng, "Machine Learning Yearning", available online published by deeplearning.ai

Other useful resources (s):

- http://www.charuaggarwal.net/neural.htm
- https://www.coursera.org/specializations/deep-learning

Evaluation Scheme:

S No	Exam	Marks	Duration	verage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes(2) -10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Introduction to Deep Learning)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	1.8
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	2
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	1.8
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	2.1
CO-5	2	3	3	3	2	1	1	1	2	3	2	2	2.1
Average	2	2.6	2.6	2.6	2.4	1	1	1	2	2.4	1.6	2	

Social Media

COURSE CODE: XXX **COURSE CREDIT:** 2 **CORE/ELECTIVE:** ELECTIVE **L-T-P:** 2-0-0
Pre-requisites: Graph Theory, Probability

Course Objectives:

1. Understanding the social media structure.
2. Understanding graph theory, particularly the algebraic description and analysis of graphs and their use in social media studies.
3. Helping scientists, artists, and sociologists understand complex social media phenomena like information diffusion, marketing, and recommendation systems in social media and evolving systems.
4. Acquiring expertise to analyze the social and digital media markets.
5. Providing insight into processing, storing, and visualizing big social media data and social graphs.

Course outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	Understand what constitutes Social and Digital Media	Familiarity
CO-2	Algebraic Graph Analysis	Assessment
CO-3	Design effective and reliable network research projects	Assessment
CO-4	Matrix and Tensor Factorization with Recommender System Applications	Assessment
CO-5	Graph Signal Processing in Social Media	Assessment
CO-6	Big Data Analytics for Social Networks	Assessment

Course Contents:

Unit	Topics	Lectures Required
1	**Graphs in Social and Digital Media** - Dominant social networking/media platforms, Collecting data from social media sites, Social media graphs, Big data issues in social and digital media	3
2	**Mathematical Preliminaries:** Graphs and Matrices & Algebraic Graph Analysis, Matrix decompositions, Applications of graph analysis, Graph clustering, Graph anomaly detection	3
3	**Web Search Based on Ranking** - Information Retrieval, Background, Relevance Beyond the Web Page, Ranking in Heterogeneous Networks	3
4	**Label Propagation and Information Diffusion in Graphs** - Graph construction approaches, Label inference methods,	3

	Diffusion processes, Social network diffusion models	
5	**Graph-Based Pattern Classification and Dimensionality Reduction** - Unsupervised Methods, Supervised Methods, Semi-Supervised Methods	3
6	**Matrix and Tensor Factorization with Recommender System Applications** - Singular Value Decomposition on Matrices for Recommender Systems, Higher Order Singular Value Decomposition (HOSVD) on Tensors A Real Geo-Social System-Based on HOSVD	3
7	**Multimedia Social Search Based on Hypergraph Learning** – Hypergraphs, Game-Theoretic approaches to uniform hypergraph clustering, Spectral clustering for arbitrary hypergraphs	3
8	**Semantic Model Adaptation for Evolving Big Social Data** - Latent Model Adaptation, Parallel and Distributed Approaches for Big Data Analysis, Applications to Evolving Social Data Analysis	3
		28

Suggested Text Book(s):

- Pitas, Ioannis, ed. Graph-based social media analysis. Vol. 39. CRC Press, 2016.

Suggested Reference Book(s):

- Analyzing Social Networks 1st Edition by Stephen P Borgatti, Martin G. Everett, Jeffrey C. Johnson, SAGE Publications Ltd; 1 edition
- Influence and Behavior Analysis in Social Networks and Social MediabyMehmet Kaya, Reda Alhajj, Lecture Notes in Social Networks, Springer International Publishing
- Emerging Research Challenges and Opportunities in Computational Social Network Analysis and Mining by Nitin Agarwal, NimaDokoohaki, Serpil Tokdemir, Lecture Notes in Social Networks, Springer International Publishing

Evaluation Scheme:

S No	Exam	Marks	Duration	verage / Scope of Examination
1	T-1	15	1 hour.	Syllabus covered upto Test-1
2	T-2	25	1.5 hours	Syllabus covered upto Test-2
3	T-3	35	2 hours	Syllabus covered upto Test-3
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) -10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes	O- 1	O- 2	O- 3	O- 4	O- 5	O- 6	O- 7	O- 8	O- 9	PO- 10	PO- 11	PO- 12	Avg
CO-1	3	3	3	2	2	3	2	2	2	3	1	3	2.4
CO-2	3	3	3	2	3	2	3	2	2	3	1	3	2.5
CO-3	3	3	3	2	2	3	1	2	3	3	1	3	2.4
CO-4	3	3	3	2	3	3	2	2	3	3	1	3	2.6
CO-5	3	3	3	2	3	3	2	2	3	3	1	3	2.6
CO-6	3	3	3	2	3	3	2	2	1	3	1	3	2.4
Average	3	3	3	2	2.7	2.8	2	2	2.3	3	1	3	

Social Media Lab

COURSE CODE: XXX **COURSE CREDIT:** 1 **CORE/ELECTIVE:** ELECTIVE **L-T-P:** 0-0-2
Pre-requisites: Graph Theory, Probability, Statistics

Course Objectives:

1. To create a sustainable software and technical ecosystem driven by a large international open-source community
2. To shares common interests in networks and complex systems
3. To focus on visualization and manipulation, simplicity, and extensibility.
4. To complement the statistical analysis to discover, extract, and classify new patterns in network structure and data.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	To learn about interactive network exploration and visualization accompanied by the graph theory concepts that drive them	Familiarity
CO-2	To understand the nuances of network visualization	Assessment
CO-3	To understand a conceptual, and also an implementation perspective	Assessment
CO-4	Getting Real-world Graph Datasets explores various networks in Gephi	Assessment
CO-5	Exploring Dynamic and Multilevel Graphs focuses on two special kinds of graphs, dynamic graphs, and multilevel graphs	Assessment
CO-6	Exploring Some Useful Gephi Plugins describes several plugins that are extensively used by researchers and developers while working with Gephi	Assessment

List of Experiments:

S No	Topics	Hours
1	**Social Network Analysis Measuring, Mapping, and Modeling Collections of Connections -** The Network Perspective, The Network Analysis Research andPractitioner Landscape, Social Networks in the Era of Abundant Computation, Node-Link Diagrams: Visually MappingSocial Networks	**4**
2	**Getting Started with NodeXL, Layout, Visual Design, and Labeling -** Downloading and Installing NodeXL, Getting Started with NodeXL, Layout: Arranging Vertices in the Graph Pane, Visual Design: Making Network Displays Meaningful	**4**
3	**Calculating and Visualizing Network Metrics -** Kite Network Example, Computing Graph Metrics, Les Misérables Co-Appearance Network	**4**
4	**Preparing Data and Filtering-** Serious Eats Network Example, Filtering to Reduce Clutter and Reveal, Important Features Putting It All	**4**

	Together.	
5	**Clustering and Grouping -** The 2007 Senate Voting Analysis, Les Misérables Character Clusters, Federal Communications Commission (FCC), Lobbying Coalition Network	**4**
6	**Email: The Lifeblood of Modern Communication -** Working with Email Data, leaning email Data in NodeXL, Analyzing Personal Email Networks Creating a Living Org-Chart with an Organizational Email Network	**4**
7	**Twitter Conversation, Entertainment, and Information, All in One Network!-** The Nuts and Bolts of Twitter, Networks in Twitter Acquiring Data, Discovery with Twitter	**4**
	Total Lab Hours	**28**

Suggested Text Book(s):

- Hansen, D., Shneiderman, B., and Smith, M.A., 2010. Analyzing social media networks with NodeXL: Insights from a connected world. Morgan Kaufmann.Suggested

Reference Book(s):

- Social Analytics: Network and Text Methods with NodeXL and R.1st Edition by Shaila Miranda and Publisher Prospect Press
- Influence and Behavior Analysis in Social Networks and Social MediabyMehmet Kaya, Reda Alhajj, Lecture Notes in Social Networks, Springer International Publishing

Online Resources: -

- **https://www.youtube.com/user/brianbritt87/videos**
- **Marc SmithTutorials: https://www.youtube.com/watch?v=TiTxYSqPBaI&list=PL0FBF4A3DCF40BCE2**

Evaluation Scheme:

S No	Exam	Coverage/Scope of Examination	Marks
1	Mid Term Test	Viva and Written Exam	20
2	End Term Test	Viva and Written Exam	20
3	Lab Records		15
4	Teacher Assessment	(Quality and quantity of experiment performed, learning laboratory skills)	30
5	Attendance and discipline in lab		15
6	Total		100

Course Outcomes (COs) contribution to the Program Outcomes (POs)

Course outcomes	O- 1	O- 2	O- 3	O- 4	O- 5	O- 6	O- 7	O- 8	O- 9	PO- 10	PO- 11	PO- 12	Average
CO-1	3	3	3	2	2	3	2	2	2	3	1	3	2.4
CO-2	3	3	3	2	3	2	3	2	2	3	1	3	2.5
CO-3	3	3	3	2	2	3	1	2	3	3	1	3	2.4
CO-4	3	3	3	2	3	3	2	2	3	3	1	3	2.6
CO-5	3	3	3	2	3	3	2	2	3	3	1	3	2.6
CO-6	3	3	3	2	3	3	2	2	1	3	1	3	2.4
Average	3	3	3	2	2.7	2.8	2	2	2.3	3	1	3	

COMPUTER ANIMATION

COURSE CODE: XXX **COURSE CREDITS:** 2 **CORE/ELECTIVE: ELECTIVE L-T-P:** 2-0-0

Description

This course investigates the theory, algorithms, and techniques for describing and programming motion for animation worlds. Approaches that will be explored include keyframing systems, kinematics, the motion of articulated figures, and procedural and behavioral systems.

Pre-requisite: Computer Graphics, C

Course Objectives: Students will be able

1. To learn the basic of animation
2. To learn the fundamentals of keyframing and interpolation.
3. To understand the working of motion.
4. To understand animating behavior and articulated figures.
5. To learn the basic principles of motion capture and apply them to an animation application.
6. To understand Human figure study through the anatomy

Course Outcomes

S No	Course Outcomes	Level of Attainment
CO-1	Understand the basic of animation	Familiarity
CO-2	Able to learn the fundamentals of keyframing and interpolation.	Assessment
CO-3	Understand the working of motion	Familiarity
CO-4	Demonstrate the skills for animating behavior and articulated figures	Assessment
CO-5	Able to learn the basic principles of motion capture	Assessment
CO-6	To develop animation application and facial recognition	Usage

Course Contents:

Unit	Contents	Lectures Required
1	**Introduction-** Motion perception, Heritage of animation, Animation production, Computer animation production, History of computer animation, **Technical Background-** Spaces and transformations, Orientation representation	4
2	**Interpolating Values-** Interpolation, Controlling the motion of a point along a curve, Interpolation of orientations, Working with paths, **Interpolation-Based Animation-** Key-frame systems, Animation	4

	languages, Deforming objects, Three-dimensional shape interpolation, Morphing (two-dimensional)	
3	**Kinematic Linkages-** Hierarchical modeling, Forward kinematics, Inverse kinematics, **Motion Capture-** Motion capture technologies, Processing the images, Camera calibration, Three-dimensional position reconstruction, Fitting to the skeleton, Output from motion capture systems, Manipulating motion capture data	**5**
4	**Physically Based Animation**- Basic physic, Spring animation examples, Particle systems, Rigid body simulation, Cloth, Enforcing soft and hard constraints, **Fluids-** Liquids and Gases: Specific fluid models, Computational fluid dynamics	**5**
5	**Modeling and Animating Human Figures**- Overview of virtual human representation, Reaching and grasping, Walking, Coverings, **Facial Animation:** Human face, Facial models, Animating the face, Lip-sync animation	**5**
6	**Behavioral Animation-** Primitive behaviors, Knowledge of Environment, Modeling intelligent behavior, Crowds, **Special Models for Animation-** Implicit surfaces, Plants, Subdivision surfaces	**5**
	Total Lecture Hours	**28**

Text Book

- Computer Animation: Algorithms and Techniques, 3rd Edition, by Rick Parent (Morgan Kauffmann, 2012), ISBN: 0124158420

- **Reference Books**
- Foundations of Physically Based Modeling & Animation by Donald H. House and John

B. Keyser CRC Press, 2016, ISBN: 9781482234602

- Physics for Game Developers by David M. Bourg, O'Reilly, 2002, ISBN: 0596000065

Evaluation Scheme:

S No	Exam	Marks	Duration	verage/ Scope of Examination
1	T-1	15	1 Hour	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes	O- 1	O- 2	O- 3	O- 4	O- 5	O- 6	O- 7	O- 8	O- 9	PO- 10	PO- 11	PO- 12	Avg
CO-1	1	1		1	1	1	1	1		1	1		1
CO-2	2	2	2			2		2			2		2
CO-3	3	3	3				3	3					3
CO-4		1	1	1	1			1	1	1	1	1	1
CO-5	3	3		3	3				3	3	3	3	3
CO-6	2		2	2	2	2	2	2	2	2	2	2	2
Avg	2.2	2	2	1.8	1.8	1.7	2	1.8	2	1.8	1.8	2	1.9

COMPUTER ANIMATION LAB

COURSE CODE: XXX **COURSE CREDITS:** 1 **CORE/ELECTIVE:** ELECTIVE **L-T-P:** 0-0-2

Description

The students will discover the fundamental principles of animation & exploit these fundamental principles to create convincing character motion.

Course Objectives: Students will be able

1. To learn the basic tool of animation
2. To learn the fundamentals of sketching and drawing.
3. To learn the design of animation character.
4. To develop an animation application

Course Outcomes

S No	Course Outcomes	Level of Attainment
CO-1	Capable to work with basic Animator Drawing Tool	Familiarity
CO-2	Demonstrate the skills for sketching and drawing.	Assessment
CO-3	Capable to develop animation character	Assessment
CO-4	Capable to develop animation application	Usage

List of Experiments

S No	Experiment	Hours
1	**Using Animator's Drawing Tools** The Animation Table (lightbox), Field charts, Line Testing Camera, Peg bar, Punching Machine	**4**
2	**Sketching and Drawing** Drawing for Animation, Exercises and Warm-ups on Pegging Sheet, Quick studies from real life, sequential movement drawing, Caricaturing the action, thumbnails drawing for motion	**8**
3	**Developing an Animation Character** Incorporating various moods and shades of a character Various gestures and facial expressions of the character	**8**
4	**Anatomy and Body Language** Front, side and back view of the character, Anatomy and Body Language of the character Caricaturing the character	**8**
	Total Lab Hours	**28**

Textbook

- The complete animation course by Chris Patmore Pub.-Baron's Educational Series (New York)

Reference book

- Animation Unleashed by Ellen Bessen, Michael Weise Productions Pub.2008 (U.S.A)
- The Animator's Survival Kit by Richard Williams, Arrar Straus & Giroux Pub.(U.S.A)

Evaluation Scheme:

S No	Exam	Coverage/Scope of Examination	Marks
1	Mid Term Test	Viva and Written Exam	20
2	End Term Test	Viva and Written Exam	20
3	Lab Records		15
4	Teacher Assessment	(Quality and quantity of experiment performed, learning laboratory skills)	30
5	Attendance and discipline in lab		15
6	Total		100

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Avg
CO-1	1	1		2	1	3	1	1		2	1		1.4
CO-2	2	1	2			2		2		3	2	1	1.9
CO-3	3	2	3		2		2	3			3		2.6
CO-4		1	2	1	3			1	3	2	1	2	1.8
Avg	2	1.3	2.3	1.5	2	2.5	1.5	1.8	3	2.3	1.8	1.5	2

(C): COURSE DESCRIPTION

Course Name:	**CYBER WARFARE AND CYBER CRIME**
Course Code:	**18M1WCI113**
Course Credits:	**3 (3-0-0)**
Branch and Semester:	**CSE and IT–M. Tech.**
Session:	**Jun – Dec, 2018**

Prerequisite

CE/CS/SE (or equivalent) and knowledge of Java.

Course Objective

The primary objective of this course is to provide a basic understanding of full-spectrum cyberspace operations, the complexities of the cyberspace environment, as well as planning, organizing, and integrating cyberspace operations. The course will consist of presentations and exercises that will teach you how to develop a cyber-operations design and bring it to fruition. Further, purpose of cybercrime is to introduce students with the technical, social and legal aspects of cybercrime as well as expose students to theories and tools that enable scientific exploration of this phenomenon.

The major objectives of the course are:

- Understanding of full-spectrum cyberspace operations
- The complexities of the cyberspace environment
- Planning, organizing, and integrating cyberspace operations
- To become familiar with various definitions and typologies of cybercrime
- To understand the contribution of hackers, victims and IT managers to cybercrime
- To apply criminological theories in the study of cybercrime
- To become familiar with technical tools allowing the collection of data in cyber space
- To explain the role of both the private sector and law enforcement agencies in investigating, prosecuting and preventing cyber crime.

Course Contents/Lecture Plan

S No	Topics	Hrs
1.	**Introduction of cyber war fare** what is cyber warfare, potential targets of cyber ware fare, understanding the cyberspace environment and design, designing approach of cyber space, cyber space operational approaches	4
2.	**Cyber Weapon and cyber tactics** What is cyber weapon, Comparison of selected cyber weapons and their associated attacking strategies	3

3.	**Security techniques** Security attacks, security services, security services, encryption/decryption algorithms, security applications	3
4.	**Computer and internet basics** Computer hardware and software, operation of the internet, infrastructure and usage of the internet	3
5.	**Cyber crime** Defining cyber crime, classifying cyber offences: computer offenses, computer-facilitated offences, computer-supported offences, prevalence and frequency of cyber crimes.	4
6.	**Methods and techniques used in commission of offences** Malicious software: viruses, worms, Trojan horses, spyware, adware and scareware	4
7.	**Hacking** Classification of hackers, techniques used by hackers: spamming, phising, and skimming botnets, distributed denial of service attacks	3
8.	**Computer offences** Illegal access, illegal interception, data and system interference, misuse of devices	2
9.	**Offences against person** Cyber stalking, grooming, voyeurism and cyber bullying	4
10.	To explain the role of both the private sector and law enforcement agencies in investigating, prosecuting and preventing cyber crime	4
11.	**Fraud and financial crime** Fraud, identity theft, money laundering, copyright infringement: software privacy	3
12.	**Theoretical explanation of cybercrimes** Cultural and sub cultural, sociological and opportunity	2
13.	**International and jurisdictional issues** Cyber terrorism, cyber ware fare, human trafficking, perspective jurisdiction, adjudicative jurisdiction and enforcement jurisdiction	3
	Total	**42**

(D): COURSE DESCRIPTION

Course Name: CRYPTOGRAPHY AND INFORMATION SYSTEM SECURITY
Course Code: **18M11CI114**
Course Credits: **3** (3-0-0)
Branch and Semester: M. Tech.
Session:
Last updated on: 06-4-2018
Faculty Coordinators:

Pre-requisite Course: Computer Networks, Discrete Mathematics

Description & Rationale:

In this module, students will be provided with the contemporary knowledge of Cryptography techniques along with the security of information systems. It focuses on introducing the concepts, principles, techniques and methodologies required to design and assess the security of information exchange over complex networks, information systems and applications.

Objectives:

- To understand how cryptography can be used as an effective tool in providing assurance concerning privacy and integrity of information.
- To recognize the concept of encryption/decryption.
- To describe the different types of ciphers along with the identification of the characteristics of a good cipher.
- To provide skills to design security protocols for solving security problems.
- To develop skills necessary to help organizations in designing, testing and implementing well-planned information security measures for for information systems.

Course Contents / Lecture Plan:

S No	Topics	Hrs
1	**Introduction:** Security Attacks: Motives, vulnerabilities, Defense strategies and techniques, Various Attacks- DoS, DDoS, Session Hijacking and Spoofing, Phishing, Buffer Overflow, Format String Attacks, SQL Injection, Malicious Software, Prevention and Detection, Data Protection, Response, Recovery and Forensics.	4
2	**Basics of Cryptography:** Symmetric Cipher Model, Substitution Techniques, Transportation Techniques, Other Cipher Properties- Confusion, Diffusion, Block and Stream Ciphers.	4
3	**Secret Key Cryptography:** Data Encryption Standard (DES), Strength of DES, Block Cipher, Design Principles and Modes of Operations, Triple DES.	6
4	**Public Key Cryptography:** Principles of Public Key Cryptosystems, RSA Algorithm, Diffie-Hellman Key Exchange algorithm	5
5	**Cryptographic Hash Functions:** Applications of Cryptographic Hash Functions, Secure Hash Algorithm, Message Authentication Codes – Message Authentication Requirements and Functions, HMAC, Digital signatures, Digital Signature Schemes, Authentication Protocols, Digital Signature Standards. Authentication Applications-Kerberos, Key Management and Distribution, X.509 Directory Authentication service, Public Key Infrastructure.	7
6	**Electronic Mail Security**-Pretty Good Privacy, S/MIME**, Operating System Protection**-Memory and Address protection, File Protection Mechanism, User Authentication. **Database Security-** Security Requirement, Reliability and Integrity, Sensitive data, Multilevel Databases.	6
7	**IP Security:** Overview, Architecture, Authentication Header, Encapsulating Security Payload, Combining security Associations, Internet Key Exchange, Web Security: Web Security Considerations, Secure Sockets Layer and	5

	Transport Layer Security, Electronic Payment.	
8	**Intrusion Detection Systems and Firewalls** Intruders, Intrusion Detection, Password Management, Firewalls-Need, Characteristics, Types of Firewalls, Placement of Firewalls, Firewall Configuration, Trusted systems.	5
	Total	**42**

(E): COURSE DESCRIPTION

Course Name:	**Secure Software Design**
Course Code:	18M1WCI115
Course Credits:	**3** (3-0-0)
Branch and Semester:	M. Tech.
Session:	
Last updated on:	06-4-2018

Objective of the course:

We will also cover various analysis and design techniques for improving software security, as well as how to use these techniques and tools to improve and verify software designs and security. This course provides a foundation for building secure software by applying security principles to the software development lifecycle.Topics covered include: security in requirements engineering, secure designs, risk analysis, threat modeling, deploying cryptographic algorithms, defensive coding, penetration testing, fuzzing, static analysis, and security assessment. Students will learn the practical skills for developing and testing for secure software while also learning sound security fundamentals from real-world case studies. Finally, we will also discuss the technical trends affecting software security.

Prerequisites

This course will be challenging, and students are expected to learn the necessary technologies.

This course requires very good programming/development skills (C/C++ and a scripting language, such as Python, Ruby or PHP) and a solid background in operating systems (especially Linux or UNIX variants).

Outcomes:

Students will learn to:

- Apply contemporary formal mathematical modelling techniques to model and analyze the security of a software system
- Identify project security risks & selecting risk management strategies.

- Use statistical methods to collect and analyze metrics for assessing and improving the security of a product, process, and project objectives.
- Describe and discuss security concerns designs at multiple levels of abstraction
- Comply with data privacy and security requirements when designing a software system.
- Design a software solution for secure access and protection of data.
- Use quality assurance activities and strategies that support early vulnerability detection and contribute to improving the development process.

Contents / Lecture Plan:

S No	Topics	Hrs
1.	Software Design as an Element of the Software Development Lifecycle	**6**
2.	How High-Level Design (or Architecture) handles Security Problems	**6**
3	Software Design as an Abstraction. Apply contemporary formal mathematical modelling techniques to model and analyze the security of a software system	**6**
4.	Software Design Methods and Tools. Describe and discuss security concerns designs at multiple levels of abstraction, Use statistical methods to collect and analyze metrics for assessing and improving the security of a product, process, and project objectives.	**6**
5.	Software Design Threats and Mitigations. Comply with data privacy and security requirements when designing a software system, Design a software solution for secure access and protection of data.	**10**
6.	Use quality assurance activities and strategies that support early vulnerability detection and contribute to improving the development process.	**4**
7.	Bitcoin Foundations	**4**
	Total	**42**

(F): COURSE DESCRIPTION

Course Name: **Advanced Mobile and Distributed Computing**
Course Code: 18M1WCI115
Course Credits: 3 (3-0-0)
Branch and Semester: M.Tech 2nd sem
Session: Jan – Jun, 2018
Last updated on: 07-12-2017
Faculty Coordinators: Rajni Mohana

Pre-requisite Course: Students are expected to have a solid grasp of the fundamentals of computer system including a basic understanding of the operation of the computer, especially CPU.

Description & Rationale:

Prior knowledge in computer architecture and networking is required. The prerequisite courses include the following two: • Computer Architecture • Introduction to Computer Networks

Course Objectives (Post-conditions)

Knowledge objectives:

1. It focuses on leading system architecture, high speed interconnects, and programming models that have been used for parallel and distributed computing environments.
2. This course will cover fundamental principles, advanced algorithms, and engineering tradeoffs in building large-scale parallel and distributed computing systems, as well as the high speed interconnects that bring them all together.
3. Students will gain an in-depth understanding of research and development in HPC, and their impact on computational sciences.

Application objectives:

1. Grasp a thorough understanding on the advances of technologies, system architecture and communication architecture that propelled the growth of parallel and distributed computing systems
2. 2 Accomplish a good understanding of principles and practices in high speed interconnects
3. Gain an appreciation on the challenges and opportunities faced by parallel systems, and cloud computing environments

Course Contents / Lecture Plan:

S No	Topic	Hrs
1	Hardware Architecture - Symmetric Multiprocessing , Distributed Shared Memory, Multicomputers	7
2	Software Architecture - Client server architecture , 3-tier architecture , N-tier architecture, Peer-to-peer	7
3	Cluster computing	7
4	Grid computing	7
5	Virtualisation and Cloud Computing	7
6	Recent trends in processor technologies - Superscalar processors, Multi-core processors, Embedded processors	7
	Total	42

(H): COURSE DESCRIPTION

Course Name: **Security Design and Architecture**
Course Code: 18M1WCI114
Course Credits: 3 (L=3, T=0, P=0)
Course Type: Elective
Branch and Semester: M. Tech. 1st Year
Session: July–December 2018
Instructors: Shailendra Shukla

Introduction:

This course involves study to explore Security Architecture of a products/systems overall architecture and to provide guidance during the design of the product/system. Security Architecture is the design artifacts that describe how the security controls (security countermeasures) are positioned and how they relate to the overall systems architecture. The main target of the course is to provide knowledge at the standard of Certified Information Systems Security Professional (CISSP).

Pre-requisites: Operating System, Computer Organization, Computer Networks and Programming Background.

Scope and Objectives of the Course

This module aims to provide a broad coverage of some new advanced topics in the field of computer networks.

Course Outlines

S No	Topics	HRS
1	**Secure System Design Concepts :** Layering, Abstraction, Security Domains, The Ring Model, Open and Closed Systems	4
2	**Secure Hardware Architecture** : The System Unit and Motherboard, The CPU, Memory Protection, Hardware Segmentation	4
3	**Secure Operating System and Software Architecture**: The Kernel, Users and File Permissions.	4
4	**Security Architecture:** Trusted Computing base, Recovery procedure, Vulnerability in security architecture.	4
5	**Security Countermeasures**: Defense in depth, System hardening, Heterogeneous environment, System resilience.	3
6	**Security Models :**Confidentiality, Integrity, Availability, Access Control Models	3
7	**System Vulnerabilities:** Threats and Countermeasures: Emanations, Covert Channels, Buffer Overflows, TOCTOU/Race Conditions, Backdoors, Malicious Code (Malware), Server-Side Attacks, Web Application Attack, Mobile Device Attacks, Database Security, Cloud Security	6
8	**Evaluation Criteria:** Trusted Computer System Evaluation Criteria (TCSEC), Trusted Network Interpretation (TNI), European Information Technology Security Evaluation Criteria (ITSEC).	4

9	**Security Models:** State Machine model, Bell-LaPadula model, Lattice-Based Access Controls, Integrity Models(Biba Model, Clark-Wilson, Information Flow Model, Chinese Wall model, Noninterference, Take-Grant Protection Model), Access Control Matrix, Graham-Denning Model, Harrison-Ruzzo-Ullman Model.	10
	Total	**42**

(I): COURSE DESCRIPTION

Course Name: **Software Systems Security Lab – I**
Course Code: 18M17CI171
Course Coordinator: Dr. Yugal Kumar

Course content

The course will go through all the phases in the secure software development lifecycle (requirements, design, implementation and testing) focusing on how to incorporate security in each phase and what techniques to use. This course provides deep understanding of security vulnerabilities of software, operating systems, and web applications. Common cases of vulnerability exploitations followed by mitigation techniques of these exploitations are discussed. Topics include common security vulnerabilities in software and web application, malicious code analysis and vulnerability detection in software and web applications.

Learning outcome

The course will focus on

- To identify common security threats, risks, and attack vectors for software systems.
- To evaluate and assess current security and defence mechanisms for current software systems.
- To aware the limitations of existing defense mechanisms.
- To identify security problems in source code, web applications, binaries and assess the associated risks.
- To assess the security of given source code or applications.

Lab Exercises

S. No.	Lab Exercise Title
1	To study and implement simple stack overflow and heap overflow
2	To study and implement secure software development processes
3	To study and implement risk management for software security
4	To study and implement attack patterns and abuse cases
5	To study and implement common design and implementation vulnerabilities
6	To study and implement risk based security testing with threat modelling

7	To implement the code review with tools
8	To study and implement web application vulnerability assessment
9	To study and implement architectural risk analysis

(J): COURSE DESCRIPTION

Course Name: **Advanced Database System Security**
Course Code: 18M11CI113
Course Credits: 3 (3-0-0)
Branch and Semester: M. Tech.
Session:
Last updated on: 06-4-2018
Faculty Coordinators:

Pre-requisite Course: Good knowledge of programming in any modern high-level procedural programming language such as Java or C++with PL/SQL.

Description & Rationale:
In this module, students will be provided with the contemporary knowledge of the principles, practices, procedures, and methodologies to ensure security of data at rest within databases. This course and it appraises the convergence between database security and associated threat vectors/attack methods. It examines database types, security architecture, platform fundamentals, user administration, password management, security models, virtual private databases, and auditing models. This course reviews database security processes, security configuration.

Objectives:

- To understand and Describe database systems and differentiate the variant splices
- Explain the role of databases in organizations
- Explain the operating context of databases and evaluate associated risks with the databases
- Evaluate database security vulnerabilities and identify mitigation corresponding techniques
- Develop a security strategy and solution for securing databases
- Design a Database Security Audit Checklis
- Role of Database Security Experts and Standard Guidelines to be followed by database designers.

Course Contents / Lecture Plan:

S No	Topics	Hrs.
1	**Introduction to Database and Information System Security:** Why Database Security ?, Who are we securing ourself against ? Malware, Security Architecture: A	4

	never ending cycle, General Policies for the Database environment	
2	**Database Review:** Database Structure Components, Database Models, Installing on Unix, Configuration, Configuring MySQL on Unix, Additional security suggestions	4
3	**The Database as a Networked Server:** Understand the network access map for your database environment, Track tools and applications, Secure services from known network attacks, Firewall and VPNs.	4
4	Authentication and Password Security: Choose an appropriate authentication option, Choose strong passwords, Understand who gets system administration privileges, Implement account lockout after failed login attempts, Create and enforce password profiles, Use passwords for all database components **Application Security:** Reviewing where and how database users and passwords are maintained, Obfuscate application code, Secure the database from SQL injection attacks, Beware of double whammies: Combination of SQL injection and buffer overflow vulnerability, Address packaged application suites,	7
5	**Securing database-to-database communications:** Monitor and limit outbound communications, Secure database links and watch for link-based elevated privileges, Protect link usernames and passwords, Monitor usage of database links, Secure replication mechanisms, Map and secure all data sources and sink. **Trojans:** The four types of database Trojans, Baseline calls to stored procedures and take action on divergence, Control creation of and changes to procedures and triggers, Watch for changes to run-as privileges, Closely monitor developer activity on production environments, Monitor creation of traces and event monitors, Monitor and audit job creation and scheduling	7
6	**Database Security-**Security Requirement, Reliability and Integrity, Sensitive data, Multilevel Databases.	6
7	Auditing Categories: Audit logon/logoff into the database, Audit sources of database usage, Audit database usage outside normal operating hours, Audit DDL activity, Audit database errors, Audit changes to sources of stored procedures and trigger, Audit changes to sensitive data, Audit SELECT statements for privacy sets.	6
8	Some Advanced Topics: Towards Secure Data Outsourcing, Managing and Querying Encrypted Data, Security in Data Warehouses and OLAP Systems, Database Watermarking	4
	Total	**42**

(K): COURSE DESCRIPTION

Course Name: **Secure Enterprise Computing**
Course Code: 18M1WCI114
Course Credits: 3 (3-0-0)
Branch and Semester: M. Tech.
Session:
Last updated on: 20-4-2018
Faculty Coordinators:

Pre-requisite Course: Distributed Computing, Computer Network, Network Security

Description & Rationale:

Enterprise computing is a buzzword that refers to business-oriented information technology that is critical to a company's operations. Enterprise computing encompasses all the various types of enterprise software, including database management, relationship management and so on. Enterprise computing is usually seen as a collection of big business software solutions to common problems such as resource management and streamlining processes

Objectives:

- To provide knowledge on multi-tier enterprise architecture, enterprise database connectivity and distributed enterprise communications such as RMI, CORBA, DCOM.
- To provide knowledge for building scalable, secure, web enabled, and distributed enterprise systems with enterprise technologies and the Java 2 Platform Enterprise Edition (J2EE).
- To use technologies such as XML, JSP, Servlet, javabeans & EJB and tools to rapidly build e-commerce such as business-to-consumer systems, business-to business systems, enterprise application integration approaches, and general distributed and Internet-based enterprise wide systems.
- To provide services such as Naming, Directory, Trading, Activation, Messaging, Transaction and Security Services with systems assurance for the enterprise systems.

Course Contents / Lecture Plan:

S No	Topics	Hrs
1	**ENTERPRISE FOUNDATIONS:** Enterprise Architectural overview - object oriented software development for enterprise - Component Based software development for enterprise. Java Enterprise System. Enterprise Data - Basis of JDBC - interfaces -drivers. Advanced JDBC features.	4
2	**DISTRIBUTED ENTERPRISE COMMUNICATIONS ENABLING:** Distributed Enterprise Communications Basis - RMI Communication – CORBA communication - DCOM Communication – Software Development for RMI Communication	4
3	**SERVICES FOR DISTRIBUTED ENTERPRISE SYSTEMS:** Naming Services, Directory and Trading services, Activation Services, Message Services, Transaction Services, Security Services and High assurance Enterprise applications.	4
4	**ENTERPRISE WEB ENABLING:** Web Browsers and Web Servers in Enterprise. Web Programming, XML. Java Servlets - Java Server pages.	4
5	**INTEROPERABILITYAND MULTITIER ENTERPRISE COMPUTING:** Java Beans, EJB, Enterprise Application Integration, Interoperability between various computing technologies - Tools For Enterprise Computing - Patterns – Frame work	4
6	**IMPLEMENTING AND SECURING ENTERPRISE COMPUTING:** Web Services, Extensible Markup Language, Signing XML, X ML Digital Signature, X ML Encryption, Key Management, Key Information, Location, Validation, Binding, Key Registration, X ML and Databases, A Database Query Language for XML, X ML Databases, UDDI, WSDL	6
7	**SOAP:** SOAP, SOAP Roles and Nodes, SOAP Header Blocks, SOAP Fault, SOAP Data Model, SOAP Encoding, Bindings, Documents and RPC, Messaging	5

8	**WS-Security:** WS-Security, WS-Trust, WS-Policy, WS-Secure Conversation, WS-Privacy and the P3P Framework, POLICIES, WS-Federation, Pseudonyms, Authorization, Authorization without WS-Federation, WS-Addressing, WS-Reliable Messaging, WS-Coordination, WS-Transaction.	5
9	**SAML :** SAML, Assertions, Protocol, Assertion Query and Request Protocol, Authentication Request Protocol, Artifact Resolution Protocol, Name Identifier, Management Protocol, Single-Logout Protocol, Name Identifier Mapping Protocol, Authentication Context, Bindings, Profiles, Metadata, Versions, Security and Privacy Considerations, Kerberos, X509v3 Certificates, OpenID	5
	Total	**42**

(L): COURSE DESCRIPTION

Course Name:	**SECURITY INVESTIGATION**
Course Code:	18M1WCI112
Course Credits:	**3** (3-0-0)
Branch and Semester:	M. Tech.
Session:	
Last updated on:	06-4-2018

Pre-requisite Course: Computer Networks, Cryptography

Description & Rationale:

In this module, students will be provided with the contemporary knowledge of Cryptography techniques along with the security of information systems. It focuses on introducing the concepts, principles, techniques and methodologies required to design and assess the security of information exchange over complex networks, information systems and applications.

Objectives:

The student should be made to:

- Learn the security issues network layer and transport layer.
- Be exposed to security issues of the application layer.
- Learn computer forensics.
- Be familiar with forensics tools.
- Learn to analyze and validate forensics data.

Course Contents / Lecture Plan:

S No	Topics	Hrs

1	**NETWORK LAYER SECURITY &TRANSPORT LAYER SECURITY** IPSec Protocol – IP Authentication Header – IP ESP – Key Management Protocol for IPSec.Transport layer Security: SSL protocol, Cryptographic Computations – TLS Protocol	9
2	**E-MAIL SECURITY & FIREWALLS** PGP – S/MIME – Internet Firewalls for Trusted System: Roles of Firewalls – Firewall related terminology- Types of Firewalls – Firewall designs – SET for E-Commerce Transactions.	9
3	**INTRODUCTION TO COMPUTER FORENSICS** Introduction to Traditional Computer Crime, Traditional problems associated with Computer Crime. Introduction to Identity Theft & Identity Fraud. Types of CF techniques – Incident and incident response methodology – Forensic duplication and investigation. Preparation for IR: Creating response tool kit and IR team. – Forensics Technology and Systems – Understanding Computer Investigation – Data Acquisition.	9
4	**EVIDENCE COLLECTION AND FORENSICS TOOLS** Processing Crime and Incident Scenes – Working with Windows and DOS Systems. Current Computer Forensics Tools: Software/ Hardware Tools	9
5	**ANALYSIS AND VALIDATION** Validating Forensics Data – Data Hiding Techniques – Performing Remote Acquisition – Network Forensics – Email Investigations – Cell Phone and Mobile Devices Forensics.	9
	Total	**45**

(M): COURSE DESCRIPTION

Course Name: **SECURITY RISK ANALYSIS**
Course Code: 18M1WCI111
Course Credits: **3** (3-0-0)
Branch and Semester: M. Tech.
Session:
Last updated on: 26-4-2018

Pre-requisite Course: Networks Security

Description & Rationale:

This course is designed for students to learn to identify Threat, Risk and Vulnerability, as applied to enterprise IT systems. It incorporates the physical safeguards and policies necessary to meet the requirements for the protection of data in a fixed site. Students will conduct a Site Security Analysis of a given facility, based on skills and information learned in class. Gap Analysis, Gap Closure and Countermeasures will be discussed and documented, in an effort to counter identified Vulnerabilities.

In this course, students will also learn the practical skills necessary to perform regular risk analysis for their organizations. The ability to perform risk management is crucial for organizations hoping to defend their systems. Risk management should be the foundational tool used to facilitate thoughtful and purposeful defence strategies.

Objectives:

- Understand the elements of risk assessment and the data necessary for performing an effective risk assessment.
- How to map an organization's business requirements to implement security controls.
- Develop risk management models for implementing a deeper risk management program in their organization.
- Demonstrate proper risk management and risk analysis technique and methodology.
- Demonstrate vulnerability assessment and threat analysis techniques.
- Plan vulnerability assessment, threat assessment and risk analysis projects as it relates to physical security.
- Prepare and present business-based recommendations for expenditure of security funds.
- Develop administrative policies and procedures required to administer a physical security requirement in a secure environment.
- Develop plans that address facility access and the protection of structures and components that contain the automated information system and network equipment.

Course Contents / Lecture Plan:

S No	Topics	Hrs
1	**Information Security Risk Analysis:** Introduction to Risk, Going Deeper with Risk, Components of Risk, Information Security Risk, Risk Assessments and the Security Program, Information Risk Analysis Activities in a Nutshell, Federal Information Security Management Act of 2002, Gramm-Leach-Bliley Act (GLBA), ISO 27001.	4
2	**A Practical Approach:** Risk Assessment Frameworks, OCTAVE, Fair, NIST SP800-30, ISO 27005, A Comparison of the Major Activities for the Four Frameworks, A Comparison of the Major Activities for the Four Frameworks Based on Activities.	4
3	**Data Collection:** Introduction, The Project Team, The Size and Breadth of the Risk Assessment, Scheduling and Deadlines, Workload, Data Collection Mechanisms, Collectors, Containers, IT Asset Inventories, Asset Scoping, Business Impact Analysis and Other Assessments, Critical Success Factor Analysis, The Asset Profile Survey, The Control Survey	6
4	**Data Analysis:** Introduction, Compiling Observations from Organizational Risk Documents, Preparation of Threat and Vulnerability Catalogs, Overview of the System Risk Computation, Designing the Impact Analysis Scheme, Confidentiality, Integrity, Integrity, Preparing the Impact Score, Designing the Control Analysis Scheme, Designing the Likelihood Analysis Scheme	5
5	**Risk Analysis:** Introduction, System Risk Analysis, Risk Classification, Risk Rankings, Individual System Risk Reviews, Threat and Vulnerability Review, Review Activities for Organizational Risk, Review of Security Threats and Trends, Review of Audit Findings, Review of Security Incidents, Review of Security Exceptions, Review of Security Metrics, Risk Prioritization and Risk Treatment	7
6	**Risk Prioritization and Treatment**: Introduction, Organizational Risk Prioritization and Treatment, System Specific Risk Prioritization and Treatment	4
7	**Reporting:** Introduction, Introduction, Risk Analysis Executive Summary, Methodology, Results, Organizational Analysis, System Specific, Risk Register	6

8	**Maintenance and Wrap Up :** Introduction, Process Summary, Data Collection, Data Analysis, Risk Analysis, Reporting, Post Mortem, Scoping, Executive Interviews, System Owners and Stewards, Document Requests, System Profile and Control Survey, Analysis, Reporting	6
	Total	**42**

(N): COURSE DESCRIPTION

Course Name: **WEB APPLICATION SECURITY**
Course Code: **18MIWCI118**
Course Credits: 3 (3-0-0)
Branch and Semester: B.Tech/M.Tech.
Session:
Last updated on: 19-4-2018
Faculty Coordinators:

Pre-requisite Course: Web Technology, Computer Network, Network security

Description & Rationale:
Web application security is a branch of Information Security that deals specifically with security of websites, web applications and web services. At a high level, Web application security draws on the principles of application security but applies them specifically to Internet and Web systems.

Objectives:

- To understand how secure web development can be used as an effective tool in providing assurance concerning privacy and integrity of web Application.
- To understand the concept of web application security.
- To describe the different types of Threats and Attacks to web application
- To provide skills to design secure web applications.
- To develop skills necessary to help organizations in designing, testing and implementing well-planned information security measures for web application.
- To understand the concept of Bot and Botnet.

Course Contents / Lecture Plan:

S No	Topics	Hrs
1	**Introduction:** Introduction to Web Application security, network security versus Application security, Open Web Application Security Project (OWASP), OWASP Top Ten List, Security fundamentals, Input validation, Black list validation, white list validation, Attack surface reduction, classifying threats,STRIDE, CIA,CWE,CWSS	5

2	**Web Application Security Principles:** **Authentication:** Access Control overview, Proving your Identity, Two factor and Three factor Authentication, web application Authentication, Password based authentication, Validating credentials **Authorization:** Authorization goals. Session management, Types of permission, Authorization layers, Client Side Attack	4
3	**Browser Security Principles:** **The same origin policy:** Defining the same origin policy, client side vs Server side, A world without the same origin policy **Cross site scripting (XSS):** Reflected XSS, Post based Reflected XSS ,Stored XSS, Local XSS **Cross-Site Request Forgery (CSRF):** HTTP GET and the concept of safe method	3
4	**Database Security Principles:** Structured query language (SQL) Injection, SQL Injection effects Confidentiality Integrity Availability Blind SQL Injection, Solving the problems, Validating Input, Regular expression, SQL Injection in stored procedure	3
5	**File Security Principles:** Keeping Your Source Code Secret, Static Content And Dynamic Content, Revealing Source Code, Interpreted Vs Compiled Code **Security Through Obscurity:** Obfuscation , Code Obfuscation, HTML Obfuscation, Java Script Obfuscation, Levels of Obfuscation	6
6	**BOT** : Overview of Bot, Taxonomy of Bots, Basic Bot versus Advanced Bots, Good Bots versus Bad Bots, Web Crawler, Social Media Bot, Chatbot, Informational Bot, Bad Bots (Web Scrapper, Spammer, Vulnerability Scanner, Impersonator), Generalized Bot versus Specialized Bot, Bot Traffic.	4
7	**Threats of Bot to Web Applications:** Web Scraping, Transactional Fraud, Accounts -linked attacks (Semantic attacks) , Security Breach, Skewed Analytics, Content scraping, Price Scarping, database, Scraping, Click Fraud, E-Mail Spamming, Form Spamming, Man in the Browser Attack, Credential Stuffing, Account Takeover, False Accounts, Account Lockout.	4
8	**BOTNET**: Overview of BOTNET, Evolution of Botnet, Botnet classification according to their architectures, Centralized Botnet Architecture, Decentralized Botnet Architecture, BOTNET Threats to Web application, DoS, DDoS, Bitcoin Mining, Phishing and its types.	4
9	**Defense Mechanism against BOT and BOTNET:** **Preventive Approaches:** CAPTCHA, Text CAPTCHA, Image CAPTCHA, Puzzle CAPTCHA, Audio CAPTCHA, Honey Pot, Code Obfuscation. **Detective Approaches:** Mining based Approaches.	4
10	**Secure Development and Deployment:** The Penetrate And Patch Approach, Threat Modeling, Secure Code Libraries, Code Review, Security Testing, Security Incident Response Planning, Industry Standard Secure Development Methodology And Maturity Model, Security Development Life Cycle.	5
	Total	**42**

Design and Analysis of Algorithms Lab

COURSE CODE: 18B17CI472

COURSE CREDITS: 2

CORE/ELECTIVE: CORE

L-T-P: 0-0-4

Pre-requisite: None

Course Objectives:

1. Student will understand the running time using time library functions. Learn to prepare table for input size vs. running time. Learn to measure best run and worst run of the experiments.
2. Students will learn to implement various types of design for an algorithms and compare the approaches.
3. Students will learn to implement network algorithms and their applications.
4. Students will learn to implement approximate algorithms for real world problems.
5. Students will learn to implement randomized solution for difficult real world problems.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO1	Student will understand the running time using time library functions. Learn to prepare table for input size vs. running time. Learn to measure best run and worst run of the experiments.	Technical
CO2	Students will learn to implement various types of design for algorithms and compare the approaches.	Technical
CO3	Students will learn to implement network algorithms and their applications.	Technical
CO4	Student will learn to implement classical NP problems	Technical
CO5	Students will learn to implement approximate algorithms for real world problems.	Technical
CO6	Students will learn to implement randomized solution for difficult real world problems.	Technical

List of Experiments

S.No	Description	Hours
1	Getting acquainted with time.h, clocktick, cputime, I/O time	2
2	Getting acquainted with worst case time	2
3	Getting acquainted with Average case time	2
4	Getting acquainted with recursive program	2
5	Recursive Fibonacci in log n	2
6	Greedy and dynamic scheduling	2
7	Hoffman encoding	2
8	Dynamic programming: Longest common subsequence, Matrix chain multiplication	2
9	Dynamic programming: Bin packing, Knapsack	2
10	Dynamic programming: TSP	2
11	Branch and Bound TSP	2
12	Backtracking: SAT, Maze	2

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13	Sudoku solver, 8 queen	2
14	MID sem TEST	2
15	Best first search	2
16	Binomial heap MST: Prims, Kruskal	2
17	Fibonacci heap MST: Tarjan	2
18	Lazy decrease key implementation and Dijkstra	2
19	MaxFlow/ MinCut Ford-Fulkersion	2
20	Set Cover, Vertex cover	2
21	Map coloring, chromatic number	2
22	Approximate matrix inversion	2
23	Randomized Eigen vector computation	2
24	Minor Project	2
25	Minor Project	2
26	Minor Project	2
27	Minor Project	2
28	Final test	2
Total Lab hours		**56**

Suggested Books/Resources:

1. Data Structures and Algorithms with Python, Lee and Hubbard.
2. Algorithm Design, 1ST Edition, Jon Kleinberg and ÉvaTardos, Pearson
3. ink to topics related to course:
   - **a.** Python
   - **b.** SciPy
   - **c.** NumPy

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Attendance	15 Marks
4	Lab Assessment	45 Marks
	Total	100 marks

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Average
CO1	3	3	3	3	3	1	1	3	3	3	1	3	**2.5**
CO2	2	2	2	2	2	1	1	1	2		1	2	**1.6**
CO3	3	3	3	3	3	1	1	1	3	1	1	3	**2.2**
CO4	2	2	2	2	2	2	1	1	2		2	2	**1.8**
CO5	2	2	2	2	2	3	1	1	2	2	2	2	**1.9**
CO6	2	2	2	2	2	2	1	2	2	2	2	2	**1.9**
Average	**2.3**	**2.3**	**2.3**	**2.3**	**2.3**	**1.7**	**1**	**1.5**	**2.3**	**2**	**1.5**	**2.3**	

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Web Technology Lab

COURSE CODE: 18B17CI474

COURSE CREDITS: 2

CORE/ELECTIVE: CORE

L-T-P: 0-0-4

Pre-requisite: None

Course Objectives:

1. To develop the ability to design and implement web enabled applications.
2. The student shall acquire the skill to design and develop web based applications with high usability, scalability and efficiency.
3. They shall be exposed to various technologies required to design web sites
4. They shall acquire the skill to choose the technology to use based on the requirements and functionality of the web site

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO1	Basic PHP Concepts, PHP Operators, PHP Function, PHP Variables and Super globals.	Familiarity
CO2	Conditional Statements, Looping Statements, Array, Cookies, PHP Form, PHP Session, File Upload, File Handling, User login and Registration.	Usage
CO3	Database Connectivity, MySQL, MySQL connect, create DB/Table, Instructions such as select, where, order By, update and delete etc., encryption methods.	Familiarity
CO4	Create and save an XML document at the server, which contains 10users information. Write a program which takes User Id as input and returns the user details by taking the user information from the XML document.	Assessment
CO5	To get familiar with JavaScript, working with operators, Conditional Statements, looping statements, Alert Box, Confirm Box and Prompt Box, Functions, Array, event handler, regular expressions and modifiers, Cookie and form validations.	Assessment
CO6	Validate the registration, user login, user profile and payment by credit card pages using JavaScript.	Usage

List of Experiments

S.No	Description	Hours
1	Basic PHP Concepts, PHP Operators, PHP Function, PHP Variables and Super globals,	6
2	Conditional Statements, Looping Statements, Array, Cookies, PHP Form, PHP Session, File Upload, File Handling, User login and Registration	6
3	Database Connectivity, MySQL, MySQL connect, create DB/Table, Instructions such as select, where, order By, update and delete etc., encryption methods.	6
4	Project-To develops and implement, and demonstrate Database Driven Websites through a project that meet stated specifications.	4
5	Create and save an XML document at the server, which contains 10users information. Write a program which takes User Id as input and returns the user details by taking the user information from the XML document.	6
6	To get familiar with JavaScript, working with operators, Conditional Statements,	6

	looping statements, Alert Box, Confirm Box and Prompt Box, Functions, Array, event handler, regular expressions and modifiers, Cookie and form validations.	
7	Validate the registration, user login, user profile and payment by credit card pages using JavaScript.	4
8	Bean Assignments a. Create a JavaBeans which gives the exchange value of INR (Indian Rupees) into equivalent American/Canadian/Australian Dollar value. b. Create a simple Bean with a label which is the count of number of clicks. Then create a Bean info class such that only the count properly is visible in the property Window. c. Create two Beans – a) Keypad b) Display pad. After that integrate the two Beans to make it work as a calculator. d. Create two Beans Traffic Light (implemented as a label with only three background colors-red, green, yellow) and Automobile (Implemented as a Text Box which states its state/movement). The state of the Automobile should depend on the following Light Transition table	8
9	XML Concepts, XML Elements and Attributes, DTD and Schema, XML with CSS.	4
10	Install TOMCAT web server. Convert the static web pages of assignments 2 into dynamic web pages using servlets and cookies. Hint: User‟s information (user id, password, credit card number) would be stored in web. Xml. Each user should have a separate shopping cart	6
Total Lab hours		**56**

Suggested Books/Resources:

1. Web Enabled commercial Application development using HTML,DHTML, Java Script, Perl CGI" by Ivan Bayross, BPB Publication
2. "Internet and World Wide Web – How to Program" by Deitel, Deitel and Nieto ,Pearson Education Asia Publication
3. "PHP and MYSQL Manual" by Simon Stobart and Mike Vassileiou
4. "PHP and MYSQL Web Development" by Luke Welling and Laura Thomson(Pearson Education

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Attendance	15 Marks
4	Lab Assessment	45 Marks
	Total	100 marks

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Average
CO1	3	3	3	2	2	3	2	2	2	3	1	3	**2.4**
CO2	3	3	3	2	3	2	3	2	2	3	1	3	**2.5**
CO3	3	3	3	2	2	3	1	2	3	3	1	3	**2.4**
CO4	3	3	3	2	3	3	2	2	3	3	1	3	**2.6**
CO5	3	3	3	2	3	3	2	2	3	3	1	3	**2.6**
CO6	3	3	3	2	3	3	2	2	2	3	1	3	**2.5**
Average	**3**	**3**	**3**	**2**	**2.7**	**2.8**	**2**	**2**	**2.5**	**3**	**1**	**3**	

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Computer Graphics

COURSE CODE: 18B11CI515

COURSE CREDITS: 3

CORE/ELECTIVE: CORE

L-T-P: 3-0-0

Pre-requisites: Elementary Knowledge about the algorithms, programming, matrices and linear algebra is required

Course Objectives:

1. To learn and understand the basics of computer graphics applications and graphics devices
2. To learn and understand the geometric figure drawing algorithm on graphic device
3. To learn and understand the Two-Dimensional transformations
4. To learn and understand the Three-Dimensional transformations
5. To understand the concepts of solid modelling and representation
6. To learn about the Visible-Surface, Illumination and Shading

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO 1	Student will learn about the overview of computer graphic applications and graphics devices (Display Technologies, Raster Refresh (Raster- Scan), CRT, LCD displays, etc.)	Familiarity
CO 2	Student will learn about the scan conversion - lines, circles and Ellipses, filling, clipping and aliasing	Usage
CO 3	Student will learn about the Two-Dimensional transformations and matrix representation of 2D Transformations (Translations, Rotation, Reflection, Scaling and Combined Transformation) and Window-to- Viewport transformations	Familiarity
CO 4	Student will learn about the Three-Dimensional transformations and viewing in 3D	Assessment
CO 5	Student will learn about the solid modelling: representing solids, regularized Boolean Set operations, primitive instancing, sweep representations, spatial-partitioning representations - Octree representation, B-Reps and Constructive Solid Geometry	Assessment
CO 6	Student will learn about the visible surface detection, illumination and shading	Usage

Course Contents:

Unit	Contents	Lectures required
1	Introduction to Computer Graphics: Overview of Computer Graphics, Computer Graphics Application and Software, Description of some graphics devices, Input Devices for Operator Interaction, Active and Passive Graphics Devices, Display Technologies, Storage Tube Graphics Displays, Calligraphic Refresh Graphics Displays, Raster Refresh (Raster-Scan) Graphics Displays, Cathode Ray Tube Basics, Colour CRT Raster Scan Basics, Video Basics, The Video Controller, Random-Scan Display Processor, LCD displays, Touch screen, Graphics Primitives.	**4**
2	Scan conversion – lines, circles and Ellipses; Filling polygons and clipping algorithms, Scan Converting Lines, Mid-point criteria, Problems of Aliasing, end-point ordering and clipping lines, Scan Converting Circles, Scan Converting Ellipses, Filling Polygons, edge data structure, Clipping Lines algorithms– Cyrus-Beck,	**14**

	Cohen- Sutherland and Liang-Barsky, Clipping Polygons, problem with multiple components	
3	Two-Dimensional Transformations: Transformations and Matrices, Transformation Conventions, 2D Transformations, Homogeneous Coordinates and Matrix Representation of 2D Transformations, Translations and Homogeneous Coordinates, Rotation, Reflection, Scaling, Combined Transformation, Transformation of Points, Transformation of The Unit Square, Solid Body Transformations, Rotation About an Arbitrary Point, Reflection through an Arbitrary Line, A Geometric Interpretation of Homogeneous Coordinates, The Window- to-Viewport Transformations	**6**
4	Three-Dimensional Transformations and Viewing in 3D: Introduction, Three-Dimensional Scaling, Three-Dimensional Shearing, Three- Dimensional Rotation, Three-Dimensional Reflection, Three- Dimensional Translation, Multiple Transformation, Rotation about an Arbitrary Axis in Space, Reflection through an Arbitrary Plane, Matrix Representation of 3D Transformations, Composition of 3D Transformations, Affine and Perspective Geometry, Perspective Transformations, Techniques for Generating Perspective Views, Vanishing Points, the Perspective Geometry and camera models, Orthographic Projections, Axonometric Projections, Oblique Projections, View volumes for projections.	**10**
5	Solid Modelling: Representing Solids, Regularized Boolean Set Operations, Primitive Instancing, Sweep Representations, Spatial- Partitioning Representations: Octree representation, B-Reps, Constructive Solid Geometry, Comparison of Representations	**3**
6	Visible-Surface Determination: Techniques for efficient Visible-Surface Algorithms, Categories of algorithms, Back face removal, The z-Buffer Algorithm, Scan-line method, Painter‟s algorithms (depth sorting), Area sub-division method, BSP trees, Visible-Surface Ray Tracing,	**3**
	comparison of the methods	
7	Illumination and Shading: Illumination and Shading Models for Polygons, Reflectance properties of surfaces, Ambient, Specular and Diffuse reflections, Atmospheric attenuation, Phong‟s model, Gouraud shading, some examples.	**2**
8	Image Manipulation and Storage: What is an Image? Digital image file formats, Image compression standard – JPEG, Image Processing - Digital image enhancement, contrast stretching, Histogram Equalization, smoothing and median Filtering.	**Self- Learning**
Total Lectures		**42**

Suggested Text Book(s):

1. Hearn Donald & Baker, M. Pauline (1990). “Computer Graphics – C Version” Prentice Hall of India Pvt. Ltd.

Suggested Reference Book(s):

1. Foley, J.D. & Dam, A. Van (1982), “Fundamentals of Interective Computer Graphics”, Addison-Wesley
2. Harrington, S. (1983). “Computer Graphics: A Programming Approach”‟ Mc-Graw Hill Book Co.

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus

Approved in Academic Council held on 25.10.2018

4.	Teaching Assessment		Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Sr. No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	2	1	2	1	2	2	**1.8**
CO-2	3	3	3	3	3	1	2	1	3	3	3	3	**2.6**
CO-3	3	3	3	3	3	1	1	1	3	1	3	3	**2.3**
CO-4	3	3	3	3	3	3	1	1	3	1	3	3	**2.5**
CO-5	2	2	2	2	2	2	2	1	2	2	2	2	**1.9**
CO-6	2	2	2	2	2	2	2	1	2	2	2	2	**1.9**
Average	**2.5**	**2.5**	**2.5**	**2.5**	**2.5**	**1.7**	**1.7**	**1**	**2.5**	**1.7**	**2.5**	**2.5**	

Formal Languages and Automata

COURSE CODE: 18B11CI513

COURSE CREDITS: 3

CORE/ELECTIVE: CORE

: 3-0-0

Pre-requisites: Graduate level courses in C programming, algorithms and complexity of algorithms are desirable.

Course Objectives:

1. To introduce the students to the mathematical foundations of computation including automata theory
2. To introduce the students about the theory of formal languages and grammars
3. To introduce the students about the theory of Automata which includes Finite Automata, Push down Automata and Turing Machines
4. To introduce the students about the notions of algorithm, decidability
5. To introduce the students about the Complexity and computability

Course Outcome (CO):

S.No.	Course Outcomes	Level of Attainment
CO-1	Broaden knowledge of the fundamental mathematical and computational principles that are the foundation of computer science	Familiarity
CO-2	Understand the concept of Deterministic Finite Automata and Non-Deterministic Finite Automata	Usage
CO-3	Understand how to minimize the states, usage Moore and Mealy Machine	Assessment
CO-4	Understand how to use the context free grammars in languages and how to derive parse trees and solve ambiguity problems	Assessment
CO-5	Understand Normal forms for Context Free Grammar‟s Chomsky and Greibach Normal Forms	Assessment
CO-6	Understand the Push Down Automaton algorithm	Assessment
CO-7	Understand how the push down automata will accept arbitrary context free languages. To understand the properties of CFG To understand the determinism and parsing. To understand different parsing methodologies	Assessment
CO-8	Understand the basic concepts of Turing Machine, configuration of Turing Machine, computing with the Turing Machine	Usage
CO-9	Understand multiple tapes, two way infinite tape concepts, the real computers random access memories working, concept of non-deterministic Turing machines	Assessment
CO-10	Understand the computational power of languages, numerical functions applied to Turing machines, numerical functions applied to Turing machines, various mathematical models applied to Turing machines, the concept of halting problem, undecidable problems about Turing machines and grammars, properties of recursive languages, concept of polynomial decidable	Assessment

Course Contents:

Unit	Contents	Lectures required
1	Introduction &Motivation, Infinite Sets, Closures, Alphabets, Languages & Representation	**3**
2	Deterministic finite automata, Non-Deterministic finite automata, Closure Properties & Equivalences, State Minimization, Moore and Mealy Machine	**6**
3	Formal Languages, Regularity, Regular Grammars, Regular Expressions and Finite Automata	**6**
4	Context Free Grammars, Parse Trees & Ambiguity, Chomsky and Greibach Normal forms	**8**
5	Push Down Automata, Equivalence of PDA and CFG, Properties of context free languages, Determinism & Parsing DCFG, Top-down & Bottom-up Parsing	**6**
6	Turing Machine-Introduction, Notations, Recursive and Recursively Enumerable Language, Extensions of Turing machines, Non-deterministic Turing machines, Primitive Recursive Functions, Mu-recursive functions	**8**
7	Church-Turing Thesis & Universal Turing machines, Halting problem, Undecidable problems, Properties of Recursive languages	**2**
8	The Complexity Class P, Satisfiability, The Complexity Class NP, NP Completeness and Reducibility NP complete problems, Cook's Theorem, NP Complete Problems	**3**
Total lectures		**42**

Suggested Text Book(s):

1. Elements of the Theory of Computation. Harry Lewis, Christos Papadimitriou, Second Edition, Pearson Education, 1998

2. Theory of computer Science: Automata, Language and Computation - KLP Mishra N Chandra Sekhran - PHI, 3rd edn.

Suggested Reference Book(s):

1. Formal Languages and Automata- Peter Linz , Narosa Pub. 4th edn.

2. M. Sipser, Introduction to the Theory of Computation, Thomson Asia, 1997.

3. J. E. Hopcroft, R. Motwani and J. D. Ullman, Introduction to Automata Theory, Languages and Computation, Pearson, 2001.

4. D. C. Kozen, Automata and Computability, Springer-Verlag, 1997.

Other useful resource(s):

1. https://nptel.ac.in/courses/111103016/
2. Link to topics related to course:
   - i. https://ocw.mit.edu/courses/mathematics/18-404j-theory-of-computation-fall-2006/
   - ii. http://www.aduni.org/courses/theory/
   - iii. http://www.cse.iitd.ernet.in/~sak/courses/toc/
   - iv. http://cse.iitkgp.ac.in/~abhij/course/theory/FLAT/Spring13/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus

Approved in Academic Council held on 25.10.2018

4.	Teaching Assessment		Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course Outcomes (Formal Languages and Automata)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	2	2	2	2	3	3	2	1	3	2	1	**2.2**
CO-2	3	3	3	2	2	3	3	3	1	3	3	1	**2.5**
CO-3	3	3	3	2	2	3	2	3	2	2	3	2	**2.5**
CO-4	3	3	3	2	2	2	3	2	2	3	2	2	**2.4**
CO-5	3	3	3	2	2	2	2	2	1	2	2	1	**2.1**
CO-6	3	3	3	3	2	3	3	2	2	3	2	2	**2.6**
CO-7	3	3	3	3	2	3	3	2	2	3	2	2	**2.6**
CO-8	3	3	3	2	2	3	3	3	2	3	3	2	**2.7**
CO-9	3	3	3	2	2	3	3	3	2	3	3	2	**2.7**
CO-10	3	3	3	2	2	3	3	3	2	3	3	2	**2.7**
Average	**3**	**2.9**	**2.9**	**2.2**	**2**	**2.8**	**2.8**	**2.5**	**1.7**	**2.8**	**2.5**	**1.7**	

Computer Organization and Architecture

COURSE CODE: 18B11CI514
COURSE CREDIT: 3
CORE/ELECTIVE: CORE
L-T-P: 3-0-0

Pre-requisites: Basic Understanding of Computer System

Course Objectives:

1. To calculate the performance of a modern digital computer from parameters such as processor speed, cycles per instruction.
2. To understand the fixed-point and floating-point numbers are represented in a computer.
3. Discuss about pipelining in a processor functions and describe how hazards are resolved in various ways.
4. Wide understanding of memory organization and management in a modern digital computer, including virtual and physical memory, address translation, multilevel, unified, and multi-way set-associative caches, the translation-look-aside buffer (TLB), and the page table.
5. To understand the working strategies of parallel processing and multi-core computers.

Course Outcomes:

S. No	Course Outcome (Computer Organization & Architechture)	Level of Attainment
CO-1	To learn the basic concepts, terminology and evolution in computer organization and architecture	Familiarity
CO-2	Understanding the computer architecture and computer arithmetic.	Assessment
CO-3	Understanding of the computer memory and the issues related to memory.	Assessment
CO-4	Understanding the concept of memory I/O, interrupt handling and DMA.	Assessment
CO-5	Learn the organization of Processor and the concept of pipelining.	Assessment
CO-6	Learning concepts of Parallel processing and related issues.	Usage

Course Contents:

Unit	Contents	Lectures required
1	**Basic Structure of Computers: Functional units:** Basic operational concepts – Bus structures – Performance and metrics – Instructions and instruction sequencing – Hardware – Software Interface – Instruction set architecture – Addressing modes – RISC – CISC.	7
2	**Basic Processing Unit of Computers:** ALU design – Integer Representation, floating point and its Arithmetic. Interconnection Structure, Bus interconnection Structure, point to point interconnection PCI express structure.	7
3	**Computer Memory:** Cache Memory: Overview of computer Memory, Cache memory principles and its elements to design P-4 Cache organization.	6
4	**Internal and External Memory:** Semiconductor Memory: Semiconductor Main Memory, Error correction. External Memory: Magnetic Disk and Tape, RAID, SSD, Optical Memory.	
5	**Input/output:** Access of I/O devices, I/O ports, I/O control mechanisms - Program controlled I/O Interrupt controlled I/O and DMA controlled I/O I/O interfaces Program controlled I/O, Interrupt controlled I/O, and DMA controlled I/O, I/O interfaces - Serial port,	6

	Parallel port, PCI bus, SCSI bus, USB bus	
6	**Central Processing Unit:** Processor Structure and Functions: Processor structure, register organization, instruction cycle and pipelining.	4
7	**Instruction level Parallelism:** Overviews, design issues, vector processing	3
8	**Parallel Processing:** Multiple Processor Organization, Symmetric Multi-processors, cache coherence, multithreading, clusters, non- uniform memory access, and vector computation.	5
Total lectures		**42**

Suggested Text Book(s):

1. William Stallings, Computer Organization & Architecture - Designing for Performance Eighth Edition, Pearson, 2010. ISBN 978-81-317-3245-8.

2. M. Morris Mano, Computer System Architecture, Pearson.

Suggested Reference Book(s):

1. John L. Hennessy and David A. Patterson ,Computer Architecture: A Quantitative Approach, Fourth Edition, Morgan Kaufmann Publishers

2. M. Morris Mano , Computer System Architecture, Third Edition, Pearson Education Inc

3. Luiz Andre Barroso and Urs Holzle;The Datacenter as a Computer – An Introduction to the Design of Warehouse Scale Machines Morgan and Claypool Publishers

Other useful resource(s):

1. Link to NPTEL course contents: https://nptel.ac.in/syllabus/106103068/
2. Link to topics related to course: https://www.geeksforgeeks.org/computer-organization-and-architecture-tutorials/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment		Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs):

Course Outcomes (Computer Organization and Architecture)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	2	2	2	2	2	2	1	2	1	1	2	**1.8**
CO-2	3	3	3	3	1	3	1	2	2	2	2	2	**2.3**
CO-3	3	2	3	3	2	2	2	2	2	2	2	2	**2.3**
CO-4	3	3	3	2	2	3	2	2	3	2	2	2	**2.4**
CO-5	3	2	2	3	2	3	3	2	3	2	2	2	**2.4**
CO-6	3	2	2	2	3	2	2	2	3	1	2	2	**2.2**
Average	**3**	**2.3**	**2.5**	**2.5**	**2**	**2.5**	**2**	**1.8**	**2.5**	**1.7**	**1.8**	**2**	

Approved in Academic Council held on 25.10.2018

Computer Graphics Lab

COURSE CODE: 18B17CI575
COURSE CREDITS: 2
CORE/ELECTIVE: CORE
: 0-0-4

Pre-requisite: None

Course Objectives:

1. Using OpenGL for Graphics
2. Programming User-interface issues
3. Concepts of 2D & 3D object representation
4. Implementation of various scan & clipping algorithms
5. 2D modelling
6. Implementation of illumination model for rendering 3D objects
7. Visibility detection & 3D viewing
8. Implementation of a project based on learned concepts.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Using OpenGL for Graphics	Familiarity
CO-2	Programming User-Interface Issues	Assessment
CO-3	Concepts of 2D & 3D object representation	Assessment
CO-4	Implementation of various scan and clipping algorithms	Assessment
CO-5	2 D Modelling	Assessment
CO-6	Implementation of a project using learned models	Usage

List of Experiments:

S. No	Description	Hours
1	Basics of OpenGL: Draw a line, rectangle and pentagon	2
2	Implement DDA Line Algorithm	2
3	Implement Bresenham‟s Line drawing Algorithm	2
4	Implement Bresenham‟s Circle drawing Algorithm	2
5	Implement Bresenham‟s Ellipse drawing Algorithm	2
6	Implement Boundary Fill Algorithm	2
7	Implement Flood Fill Algorithm	2
8	Implement Cohen Sutherland Line clipping algorithm	2
9	Implement Liang Barsky Line clipping algorithm	2
10	Implement Sutherland-Hodgman polygon clipping algorithm	2
11	Implement Nicholl-Lee-Nicholl Line clipping algorithm	2
12	Implement Weiler-Atherton polygon clipping algorithm	2
13	MID SEM TEST	2
14	Implement 2D Translation Transformation	2
15	Implement 2D Rotation Transformation	2
16	Implement 2D Scaling Transformation	2
17	Implement 2D Shear Transformation	2
18	Implement 3D Translation Transformation	2
19	Implement 3D Rotation Transformation	2

20	Implement 3D Scaling Transformation	2
21	Group Project	2
22	Group Project	2
23	Group Project	2
24	Group Project	2
25	Group Project	2
26	Group Project	2
27	Group Project	2
28	END SEM TEST	2
Total Lab Hours		**56**

Minor Project(s) – (*Only for 2 credit lab)*

1. Interactive 3D maze
2. Scene Recreation
3. Real-time rendering Technology

Suggested Books/Resources:

1. Donald Hearn and M. Pauline Baker. "Computer Graphics with OPENGL" 3rd Edition Pearson Publishers, 2011.
2. James D. Foley, Van Adams, K.Fenier and F. Hughes, "Computer Graphics-Principle and Practices", 3rd Edition Pearson Publishers, 2002.
3. Harrington, S. "Computer Graphics: A Programming Approach" Mc-Graw Hill Book Co.

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Attendance	15 Marks
4	Lab Assessment	45 Marks
	Total	100 marks

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Average
CO-1	3	3	3	2	2	3	2	2	2	3	1	3	**2.4**
CO-2	3	3	3	2	3	2	3	2	2	3	1	3	**2.5**
CO-3	3	3	3	2	2	3	1	2	3	3	1	3	**2.4**
CO-4	3	3	3	2	3	3	2	2	3	3	1	3	**2.6**
CO-5	3	3	3	2	3	3	2	2	3	3	1	3	**2.6**
CO-6	3	3	3	2	3	3	2	2	2	3	1	3	**2.5**
Average	**3**	**3**	**3**	**2**	**2.7**	**2.8**	**2**	**2**	**2.5**	**3**	**1**	**3**	

Approved in Academic Council held on 25.10.2018

Computer Organization and Architecture Lab

COURSE CODE: 18B17CI574
COURSE CREDITS: 1
CORE/ELECTIVE: CORE
: 0-0-2

Pre-requisite: None

Course Objectives:

1. To get familiar with the working scenario of logic gates.
2. Understanding the way in which arithmetic operations are done.
3. Structure of ALU and its Design
4. Understanding of Memory Design and its issues

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Ability to understand basic structure of computer.	Assessment
CO-2	Ability to perform arithmetic operations on computer.	Assessment
CO-3	Ability to understand the memory concepts including Cache.	Assessment
CO-4	Familiarity with CPU design.	Familiarity

List of Experiments:

S. No	Description	Lab Hours
1	To Study And Verify The Truth Table Of Logic Gates	2
2	Realization Of A Boolean Function	2
3	Adders And Subtractors	2
4	Multiplexer And Demultiplexer	2
5	Registers and Counters	2
6	Booth‟s Multiplier	2
7	Design Of ALU	4
8	Memory Design	4
9	Associative Cache Design	4
10	Direct Mapped Cache Design	2
11	CPU Design	2
Total Lab Hours		**28**

Suggested/Resources:

1. Computer Organization & Design: The Hardware/Software Interface - David Patterson and John Hennessey.
2. William Stallings, Computer Organization & Architecture - Designing for Performance Eighth Edition, Pearson, 2010. ISBN 978-81-317-3245-8.
3. Dr. M. Usha, T. S. Srikanth, “Computer System Architecture and Organization”,First Edition, Wiley-India.
4. “Computer Organization” by ISRD Group, Tata McGraw-Hill.
5. Link to topics related to course:
    i. http://cse10-iitkgp.virtual-labs.ac.in/index.html

Approved in Academic Council held on 25.10.2018

Course Outcomes (COs) contribution to the Programme Outcomes (POs):

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	Average
CO-1	3	2	2	2	2	3	2	2	2	2	2	2	**2.2**
CO-2	3	3	3	2	2	3	3	2	2	2	1	1	**2.3**
CO-3	3	3	3	2	2	2	3	2	2	2	3	2	**2.4**
CO-4	3	3	2	2	2	2	2	2	3	2	2	3	**2.3**
Average	**3**	**2.8**	**2.5**	**2**	**2**	**2.5**	**2.5**	**2**	**2.3**	**2**	**2**	**2**	

Approved in Academic Council held on 25.10.2018

Multimedia Lab

COURSE CODE: 18B1WCI575
COURSE CREDITS: 1
CORE/ELECTIVE: CORE
: 0-0-2

Pre-requisite: None

Lab Course Objectives: This course focuses on the development of applications that manipulate media assets. Significant time is spent on intermediate to advanced programming and scripting as well as the synchronization of aural and graphical components. Students are requited to plan, design and implement lab projects.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	To learn how to design and develop multimedia for real world e-learning.	Familiarity
CO-2	To learn how to implement multimedia e-leaning in Macromedia Flash.	Assessment
CO-3	Students will learn to create multi-user multimedia applications.	Assessment
CO-4	Students will learn to create a 3D multimedia application.	Assessment
CO-5	Students will learn to write interactive programs on the Android.	Assessment
CO-6	Students will learn to analyze and design's to interact with other apps on the device	Usage

List of Experiments:

S. No	Description	Hours
1	Write a program to justify a text entered by the user on both left and right hand side. for example the test " An architect may have a graphics program to draw an entire building but be interested in only ground floor", can be justified in 30 columns. An architect may have a graphics programs draw an entire building but interested in ground floor.	**2**
2	Study the notes of a piano and stimulate them using the keyboard and store them in file.	**1**
3	Write a program to read a paragraph and store it to a file name suggested by the author. Devise a routine to produce the animation effect of a square transforming to a triangle and then to a circle	**2**
4	To implement text and image compression algorithms: Huffman coding, Lempel-Ziv algorithm, Lempel–Ziv–Markov chain algorithm (LZMA), run length encoding, entropy encoding, area image compression, DPCM and predictive coding	**3**
5	Write a program to show a bitmap image on your computer screen.	**2**
6	Create a web page for a clothing company which contains all the details of that company and at least five links to other web pages.	**2**
7	Write a program by which we can split mpeg video into smaller pieces for the purpose of sending it over the web or by small capacity floppy diskettes and then joining them at the destination.	**4**
8	Write a program to simulate the game of pool table.	**4**
9	Write a program to simulate the game mine sweeper.	**4**
10	Write a program to play "wave" or "midi" format sound files.	**4**

Total Lab Hours	**28**

Suggested/Resources:

1. Flash MX Action Script Programming, Robert Reinhardt and Joey Lott, Wiley.
2. Flash 5 Magic with Action Script, J. Scott Hamlin and David J. Emberton, Techmedia
3. Beginning Android Application Development, Wei-Meng Lee, paperback
4. An introduction, Villamil & Molina, Multimedia Mc Milan, 1997
5. Multimedia: Sound & Video, Lozano, 1997, PHI, (Que)
6. Multimedia: Production, planning and delivery, Villamil & Molina,Que, 1997
7. Multimedia on the PC, Sinclair,BPB
8. Multimedia: Making it work, Tay Vaughan, fifth edition, 1994, TMH.
9. Multimedia in Action by James E Shuman, 1997, Wadsworth Publ.,
10. Multimedia in Practice by Jeff coate Judith, 1995,PHI.
11. Multimedia Systems by Koegel, AWL
12. Multimedia making it Work by Vaughar, etl.
13. Multimedia Systems by John .F. Koegel, 2001, Buford.
14. Multimedia Communications by Halsall & Fred, 2001,AW
15. Link to topics related to course:
    a. https://nptel.ac.in/courses/117105083/

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Attendance	15 Marks
4	Lab Assessment	45 Marks
	Total	100 marks

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO 9	PO 10	PO1 1	PO1 2	Avera ge
CO1	2	1	1	2	1	2	2	1		2	1	1	**1.5**
CO2	1	1			1	1	1	1	1	1	1	1	**1**
CO3	1	1	1		1	1	1	1	1	1	1	1	**1**
CO4	1	1	1	1	1	1	1	1	1	1	1	1	**1**
CO5	1	1	1	1	1	1	1	1		1	1	1	**1**
CO6	1	1	1		1	1	1			1	1	1	**1**
Average	**1.2**	**1**	**1**	**1.3**	**1**	**1.2**	**1.2**	**1**	**1**	**1.2**	**1**	**1**	

DETAILED COURSE DESCRIPTIONS

ELECTIVE I

Approved in Academic Council held on 25.10.2018

Data Analytics

COURSE CODE: 18B1WCI831

COURSE CREDIT: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisites: Linear algebra, calculus, probability theory and statistics

Course Objectives:

Data Analytics is the science of analyzing data to convert information to useful knowledge. This knowledge could help us understand our world better, and in many contexts enable us to make better decisions. While this is the broad and grand objective, the last 20 years has seen steeply decreasing costs to gather, store, and process data, creating an even stronger motivation for the use of empirical approaches to problem solving.

Course outcomes:

S.No.	Course outcomes (Advanced Algorithms) (XXXXX)	Level of Attainment
CO-1	Gaining factual knowledge regarding data acquisition, data cleansing, and various aspects of data analytics and visualization	Familiarity
CO-2	Learning the principles of data analytics and its underlying methods and algorithms	Assessment
CO-3	Learning to apply the methods of data collection and data analytics to solve business and related problems in support of business decision-making	Assessment
CO-4	Developing the skills necessary to use related software tools to perform data collection, cleansing, and analytics	Usage

Course Contents:

Unit	Contents	Lectures required
1	Introduction to the course, Descriptive Statistics, Probability Distributions	**5**
2	Inferential Statistics through hypothesis tests, Permutation & Randomization Test	**4**
3	Regression, ANOVA(Analysis of Variance)	**5**
4	Differentiating algorithmic and model based frameworks	**7**

	Regression : Ordinary Least Squares, Ridge Regression, Lasso Regression, K Nearest Neighbours Regression & Classification	
5	Bias-Variance Dichotomy, Model Validation Approaches Logistic Regression, Linear Discriminant Analysis Quadratic Discriminant Analysis Regression and Classification Trees Support Vector Machines	**8**
6	Ensemble Methods: Random Forest, Neural Networks, Deep learning	**4**
7	Clustering, Associative Rule Mining, Challenges for big data anlalytics	**4**
8	Creating data for analytics through designed experiments, Creating data for analytics through Active learning Creating, data for analytics through Reinforcement learning	**5**
Total lectures		**42**

Suggested Reference Book(s):

1 Hastie, Trevor, et al. The elements of statistical learning. Vol. 2. No. 1. New York: springer, 2009.

2. Montgomery, Douglas C., and George C. Runger. Applied statistics and probability for engineers. John Wiley & Sons, 2010.

Other useful resource(s):

1. Link to NPTEL course contents: https://onlinecourses.nptel.ac.in/noc15_mg05/preview

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Data Analytics)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	**1.8**
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	**2**
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	**1.8**
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	**2.1**
Average	**2**	**2.5**	**2.5**	**2.5**	**2.5**	**1**	**1**	**1**	**2**	**2.3**	**1.5**	**2**	

Big Data

COURSE CODE: 18B1WCI832

COURSE CREDIT: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisites: None

Course Objectives:

1. To learn the basic concepts and terminology in big data analytics
2. To learn about the map reduce and the new software stack
3. To learn about the mining of data streams, estimating moments and windowing, link analysis: page rank and efficient computation of page rank
4. To learn concepts associated with frequent item sets from big data and counting frequent items from stream
5. To learn about clustering for big data and mining of social network graph
6. To learn about recommendation systems, collaborative filtering and dimensionality reduction

Course outcomes:

S.No.	Course outcomes	Level of Attainment
CO-1	To learn the basic concepts and terminology in big data analytics	Familiarity
CO-2	To learn about the map reduce and the new software stack	Familiarity
CO-3	To learn about the mining of data streams, estimating moments and windowing, link analysis: page rank and efficient computation of page rank	Assessment
CO-4	To learn concepts associated with frequent item sets from big data and counting frequent items from stream	Assessment
CO-5	To learn about clustering for big data and mining of social network graph	Assessment
CO-6	To learn about recommendation systems, collaborative filtering and dimensionality reduction	Usage

Course Contents:

Unit	Contents	Lectures required
1	Introduction to Big Data: Big data time line, Why this topic is relevant now? Is big data fad? Where using big data makes a difference? Introduction to statistical modelling and machine learning, Ordinary data processing versus big data processing: Challenges and opportunities	**5**
2	Map Reduce and the New Software Stack: Distributed File Systems, Map Reduce, Algorithms Using Map Reduce, Complexity Theory for Map Reduce	**6**
3	Mining Data Streams: The Stream Data Model, Sampling Data in a Stream, Filtering Streams, Counting Distinct Elements in a Stream, Estimating Moments and Windowing, Decaying Windows	**8**
4	Link Analysis: Page Rank and Efficient Computation of Page Rank, Topic-Sensitive Page Rank, Link Spam, Hubs and Authorities	**8**
5	Frequent Item sets from Big Data: The Market-Basket Model, Market Baskets and the A-Priori Algorithm, Handling Larger Datasets in Main Memory, Limited-Pass Algorithms, Counting Frequent Items in a Stream	**8**
6	Clustering for Big Data: Introduction to Clustering Techniques, Hierarchical Clustering, Clustering in Non-Euclidean Spaces, Clustering for Streams and Parallelism	**7**
Total lectures		**42**

Suggested Text Book(s):

1. Anand Rajaraman and Jeffery David Ullman, Mining of Massive Datasets, Cambridge University Press, 2012

Suggested Reference Book(s):

1. Jared Dean, Big Data, Data Mining and Machine Learning, Wiley Big data Series, 2014
2. Judith Hurwitz, Alan Nugent, Fern Halper and Marica Kaufman, Big Data for Dummies, Wiley Press, 2013

Other useful resource(s):

1. Link to NPTEL course contents: https://nptel.ac.in/courses/106106142/
2. Link to topics related to course:
   - **h.** http://www.dbta.com/Columns/Big-Data-Notes/
   - **i.** https://people.cs.kuleuven.be/~joost.vennekens/DN/bigdata.pdf
   - **j.** https://www.tutorialride.com/big-databases/big-database-tutorial.htm

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Big Data)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	3	2	2	3	2	2	2	3	1	3	**2.4**
CO-2	3	3	3	2	3	2	3	2	2	3	1	3	**2.5**
CO-3	3	3	3	2	2	3	1	2	3	3	1	3	**2.4**
CO-4	3	3	2	2	3	3	2	2	2	3	1	3	**2.4**
CO-5	3	3	3	2	3	3	2	2	3	3	2	2	**2.6**
CO-6	3	3	3	2	3	3	2	2	2	3	1	2	**2.4**
Average	**3**	**3**	**2.8**	**2**	**2.7**	**2.8**	**2**	**2**	**2.3**	**3**	**1.2**	**2.7**	

Network Management

COURSE CODE: 18B1WCI834

COURSE CREDIT: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisites: Computer Networks, Cryptography and Network Security

Course Objectives:

1. Learn to develop applications to manage Networks.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Become familiar with the Network Management Standards	Usage
CO-2	Understand the SNMP protocols	Usage
CO-3	Understand how large-scale Network Management Systems operate	Usage
CO-4	Understand how large-scale Network Management Systems are configured	Usage
CO-5	Advanced network Management Tools and Systems	Assessment
CO-6	Web Based Network Management Systems	Assessment

Course Contents:

Unit	Contents	Lectures required
1	**Data Communications and Network Management Overview** Review of Computer Network Technology, Basic Foundations of Network management, standards, models and languages	10
2	**Network Management Models** SNMP v1 Organisation and Information models, SNMP v1 Communication and functional Models, SNMP v2, SNMP v3, SNMP management RMON	14
3	**Network Design** Design of Data Communication Networks, Design of Tele Communication Networks, Design of Trasportation networks	6

4	**Broadband Network Management:** ATM Networks, Broadband Network Management: Access Networks, TMN	**6**
5	**Network Management Tools:** Network Management Tools systems and applications, Network Management applications	**4**
6	**Web Based Network Management:** Ubiquitous Web Based Network Management	**2**
Total lectures		**42**

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Suggested Textbook:

2. Mani Subramanian., Pearson Education, *Network Management Principals and Practices*

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Network Managemen)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	2	3	2	2	3	2	3	2	2	3	3	**2.5**
CO-2	3	2	3	2	2	3	3	2	2	3	3	3	**2.6**
CO-3	2	2	2	2	2	3	3	3	2	2	3	3	**2.4**
CO-4	3	2	3	2	3	2	2	3	3	3	2	2	**2.5**
CO-5	3	2	2	2	3	2	2	2	2	3	3	3	**2.4**
CO-6	2	3	3	3	3	2	3	2	2	3	3	2	**2.6**
Average	**2.7**	**2.2**	**2.7**	**2.2**	**2.5**	**2.5**	**2.5**	**2.5**	**2.2**	**2.7**	**2.8**	**2.7**	

Graph Theory

COURSE CODE: 18B1WCI833

COURSE CREDIT: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisites: None

Course Objectives:

1. To present a rigorous introduction to the fundamentals of Graph Theory and Graph algorithms.
2. To enable the students to model various applications from Computer Science and Engineering using Graphs.
3. To introduce the techniques to store, manipulate and answer queries about a graph using a computer.
4. To learn proof techniques and algorithms involving graphs.
5. To learn about open problems in graph theory

Course Outcomes:

S.No.	Course outcomes	Level of Attainment
CO-1	To learn the basic terminology and underlying principles of Graph theory	Familiarity
CO-2	To learn the Applications of Connectivity and Applications of Trees.	Assessment
CO-3	To learn the Applications of Matchings, Colourability, and Planarity.	Assessment
CO-4	Model real world problems using graph theory	Usage

Course Contents:

Unit	Contents	Lectures required
1	**Introduction:** Scope, Basic concepts and terminology Representation: Adjacency Matrix, Incidence Matrix, Cycle Matrix, Cut-set Matrix, Path Matrix, etc	4
2	**Applications to Theoretical Computer Science:** Determining lower bounds, Adversary arguments, Problem reductions, NP-completeness, etc.	4
3	**Applications of Connectivity:** Reliable communication network design, Cycle detection, Searches, etc.	4

4	**Applications of Traversability:** Shortest paths, Optimal tours, TSP, etc. **Applications of Trees:** Spanning trees, Minimum cost constructions, Coding theory, Phylogeny construction, etc.	6
5	**Applications of Matchings/Partitioning:** Personnel assignment, Optimal assignment, Territory demarcation, etc.	6
6	**Applications of Coverings:** Geometric problems, etc. Applications of Colourability: Storage management, Timetable schedules, etc.	6
7	**Applications of Planarity:** Planarity detection, PCB design, Facilities layout and floor plan design, Software testing, Defense strategies, etc.	6
8	**Applications of Digraphs:** Circuit theory and electrical network analysis, Transport networks, Job sequencing, Disk scheduling, Participant rankings in tournaments, Choice consistency, Project planning, etc. **Applications of Flows:** Max-flow min-cut, Feasible flows, Transportation problems, etc.	6
Total lectures		**42**

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Suggested Text Book(s):

1. Narsingh Deo, Graph Theory with Applications to Engineering and Computer Science, Prentice-Hall, 1974.

2. Douglas B. West, Introduction to Graph Theory, PHI, second edition, 2001.

Suggested Reference Book(s):

1. Kenneth H. Rosen, Discrete Mathematics and its Applications, 6e, McGraw-Hill, 2007.
2. Thomas H Cormen, Charles E Leiserson, Ronald L. Rivest, and Cliff Stein,
3. Introduction to Algorithms, 2e, MIT Press, 2001.
4. Reinhard Diestel, Graph Theory, 3e, Springer-Verlag, 2005.
5. A Gibbons, Algorithmic Graph Theory, Cambridge University Press, 1985.

Other useful resource(s):

3. Link to NPTEL course contents: https://nptel.ac.in/courses/106108054/
4. Link to topics related to course:
    i. https://swayam.gov.in/course/3795-graph-theory
    ii. https://www.coursera.org/learn/graphs

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Graph Theory)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	**1.8**
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	**2**
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	**1.8**
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	**2.1**
Average	**2**	**2.5**	**2.5**	**2.5**	**2.5**	**1**	**1**	**1**	**2**	**2.3**	**1.5**	**2**	

Deep Learning

COURSE CODE: 18B1WCI835

COURSE CREDIT: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisites: None

Course Objectives:

1. Understand the major technology trends driving Deep Learning
2. Be able to build, train and apply fully connected deep neural networks
3. Know how to implement efficient (vectorized) neural networks
4. Understand the key parameters in a neural network's architecture

Course Outcomes:

S.No.	Course outcomes	Level of Attainment
CO-1	Variability models (deformation model, stochastic model).	Usage
CO-2	Properties of CNN representations: invertibility, stability, invariance	Usage
CO-3	Covariance/invariance: capsules and related models.	Usage
CO-4	Other tasks: localization, regression.	Usage
CO-5	Dynamical systems: RNNs.	Assessment
CO-6	Autoencoders (standard, denoising, contractive, etc etc)	Assessment
CO-7	Maximum Entropy Distributions	Usage
CO-8	Non-convex optimization for deep networks	Assessment
CO-9	Stochastic Optimization	Assessment

Course Contents:

Unit	Contents	Lectures required
1	What is a neural network?, Supervised Learning with Neural Networks	4
2	Why is Deep Learning taking off?, A Review of Machine Learning	4
3	Foundations of Neural Networks and Deep Learning, Binary Classification	4
4	**Logistic Regression Cost Function,** Gradient Descent, Computation graph	6
5	Logistic Regression Gradient Descent, Computing a Neural Network's Output	6
6	Explanation for vectorized Implementation, Gradient descent for Neural Networks	6
7	Random Initialization, Forward and Backward Propagation	6
Total lectures		**42**

Suggested Text Book(s):

3. François Chollet, "Deep Learning with Python", Manning Publications Company, 2018
4. Detailed course notes and slides written by the lecturer will be served as the examinable materials for the course. All required course materials are available from the institute's WebCT Web site.

Suggested Reference Book(s):

1. Josh Patterson, Adam Gibson, "Deep Learning: A Practitioner's Approach", 2nd Edition, OReilly Media

Other useful resource(s):

1. https://www.coursera.org/learn/neural-networks-deep-learning/home/welcome
2. http://www.deeplearningbook.org/lecture_slides.html
3. https://www.cs.tau.ac.il/~dcor/Graphics/pdf.slides/YY-Deep%20Learning.pdf
4. http://cs229.stanford.edu/materials/CS229-DeepLearning.pdf
5. https://www.cse.iitk.ac.in/users/sigml/lec/DeepLearningLib.pdf
6. http://deeplearning.net/tutorial/deeplearning.pdf

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Graph Theory)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	3	3	2	2	3	3	2	3	3	3	**2.8**
CO-2	3	3	3	2	1	1	2	3	2	3	3	3	**2.4**
CO-3	3	3	2	2	2	1	2	2	2	3	3	3	**2.3**
CO-4	3	3	3	2	2	1	2	3	2	3	3	3	**2.5**
CO-5	3	3	3	3	2	1	2	3	2	1	3	3	**2.4**
CO-6	3	3	3	3	2	1	2	3	2	2	3	3	**2.5**
CO-7	3	3	2	2	2	3	3	2	2	3	3	3	**2.6**
CO-8	3	3	3	3	2	2	3	3	2	1	3	2	**2.5**
CO-9	3	3	3	3	2	3	3	3	2	2	3	2	**2.7**
Average	**3**	**3**	**2.8**	**2.6**	**1.9**	**1.7**	**2.4**	**2.8**	**2**	**2.3**	**3**	**2.8**	

Data Mining

COURSE CODE: 18B11CI613

COURSE CREDITS: 3

CORE/ELECTIVE: CORE

L-T-P: 3-0-0

Pre-requisites: Data Structures, Compilers, Operating Systems, Computer Networks, Machine Learning and Genetic Algorithms.

Course Objectives:

1. To describe the concept of Data warehouse & its attributes.
2. To study different data warehouse models, architectures and implementation.
3. To understand the basic concept of data mining and its functionality.
4. To understand the concept of classification techniques and its implementation.
5. To understand the concept of association rules, different techniques and implementation details.
6. To understand the concept of cluster analysis, anomaly detection and its usage and implementation details.

Course Outcomes

S. No.	Course Outcomes	Level of Attainment
CO-1	To describe the concept of Data warehouse & its attributes	Assessment
CO-2	To study different data warehouse models, architectures and implementation	Assessment
CO-3	To understand the basic concept of data mining and its functionality	Assessment
CO-4	To understand the concept of classification techniques and its implementation	Assessment
CO-5	To understand the concept of association rules, different techniques and implementation details	Assessment
CO-6	To understand the concept of cluster analysis, anomaly detection and its usage and implementation details	Usage

Course Contents:

Unit	Contents	Lectures required
1	**Introduction:** Concepts of Data Warehouse and Data Mining including its functionalities, stages of Knowledge discovery in database(KDD) , Setting up a KDD environment, Issues in Data Warehouse and Data Mining, Application of Data Warehouse and	5

	Data Mining	
2	**Architecture:** DBMS vs. Data Warehouse, Data marts, Metadata, Multidimensional data model, Data Cubes, Schemas for Multidimensional Database: Stars, Snowflakes and Fact Constellations, Data Warehouse Architecture, Distributed and Virtual Data Warehouse, Data Warehouse Manager, OLTP, OLAP, MOLAP, HOLAP, types of OLAP, servers	**8**
3	**Introduction:** Data Mining, Motivation, Challenges, Origins of Data Mining, Data Mining Tasks, Data: Types of Data, Data Quality, Data Pre-processing, Measures of Similarity and Dissimilarity, Exploring Data: Iris Data Set, Summary Statistics, Visualization, OLAP and Multi dimensional Data Analysis	**5**
4	**Classification:** Basic Concepts andPreliminaries, Approach to Solving a Classification Problem, Decision Tree Induction, Model Over fitting, Evaluating Performance of Classifier **Alternative Techniques**: Rule-Based Classifier, Nearest-Neighbour Classifiers, Artificial Neural Network (ANN), Support Vector Machine (SVM), Ensemble Methods, Class Imbalance Problem, Multiclass Problem	**8**
5	**Association Analysis:** Basic Concepts andProblem Definition, Frequent Itemset Generation, Rule Generation, Representation of Frequent Itemsets, FP-Growth Algorithm, Evaluation of Association Patterns, Handling Categorical Attributes , Handling Continuous Attributes, Handling a Concept Hierarchy, Sequential Patterns, Subgraph Patterns	**8**
6	**Cluster Analysis:** Basic Concepts, Characteristics of Data, Clusters, Partitional Clustering, Agglomerative Hierarchical Clustering, Prototype-Based Clustering, Density-Based Clustering, Graph-Based Clustering, Cluster Evaluation **Anomaly Detection:** Preliminaries, Statistical Approaches, Proximity-Based Outlier Detection, Density-Based Outlier Detection, Clustering-Based Techniques	**8**
Total Lectures		**42**

Suggested Text Book(s):

1. Data Mining Concepts and Techniques J. Han and M. Kamber Morgan Kaufmann, 2006, ISBN 1-55860-901-6

2. Introduction to Data Mining Pang-Ning Tan, Michael Steinbach, Vipin Kumar, Pearson Education (Addison Wesley), 0-321-32136-7

Suggested Reference Book(s):

1. Mininig Massive data sets Anand Rajaram, Jure Leskovec and Jeff Ullman Cambridge University Press

Other useful resource(s):

1. https://onlinecourses.nptel.ac.in/noc18_cs14/preview
2. https://www.coursera.org/specializations/data-mining.
3. https://www.futurelearn.com/courses/data-mining-with-wekahttp://ecomputernotes.com/compiler-design

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment		Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Compiler Design)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	2	2	1	2	3	3	2	1	3	2	1	**2.1**
CO-2	3	3	2	1	1	3	3	1	3	3	3	1	**2.3**
CO-3	3	3	2	1	2	2	2	1	2	3	3	2	**2.2**
CO-4	3	3	3	2	2	2	3	2	2	1	2	2	**2.3**
CO-5	3	3	3	2	2	2	2	2	1	3	2	1	**2.2**
CO-6	3	3	3	3	2	3	3	2	2	3	2	2	**2.6**
Average	**3**	**2.8**	**2.5**	**1.7**	**1.8**	**2.5**	**2.7**	**1.7**	**1.8**	**2.7**	**2.3**	**1.5**	

Data Mining Lab

COURSE CODE: 18B17CI673

COURSE CREDITS: 2

CORE/ELECTIVE: CORE

L-T-P: 0-0-4

Pre-requisite: Introduction to Programming.

Course Objectives:

1. Practical exposure on implementation of well known data mining tasks.
2. Exposure to real life data sets for analysis and prediction.
3. Learning performance evaluation of data mining algorithms in a supervised and an unsupervised setting.
4. Handling a small data mining project for a given practical domain.
5. Develop and apply enthusiasm for learning machine learning tools and techniquesThe lab course provides the complete description about inner working of a compiler.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Practical exposure on implementation of well known data mining tasks.	Familiarity
CO-2	Exposure to real life data sets for analysis and prediction.	Technical skills
CO-3	Learning performance evaluation of data mining algorithms in a supervised and an unsupervised setting.	Computational skills
CO-4	Handling a small data mining project for a given practical domain.	Computational skills and Technical Skills
CO-5	Develop and apply machine learning tools and techniques.	Assessment

List of Experiments:

S. No.	Description	Hours
1	Introduction to Rapid Miner Studio, Weka and R	4
2	Creation of a Data Warehouse in Rapid Miner	4
3	Apriori Algorithm	8
4	FP-Growth Algorithm	8

5	K-means Clustering, K-Means ++ Clustering	8
6.	Hierarchical clustering algorithm	8
7.	Bayesian Classification	4
8.	Decision Tree	4
9.	Feature Reduction using PCA	4
10	Model Examination	4
Total Lab hours		**56**

Suggested Books/Resources:

1. Introduction to Data Mining Pang-Ning Tan, Michael Steinbach, Vipin Kumar, Pearson Education (Addison Wesley), 0-321-32136-7, 2006
2. Mininig Massive data sets Anand Rajaram, Jure Leskovec and Jeff Ullman Cambridge University Press
3. Data Mining Concepts and Techniques J. Han and M. Kamber Morgan Kaufmann, 2006, ISBN 1-55860-901-6
4. An Introduction to Information Retrieval, 2008 Cambridge UP.
5. https://onlinecourses.nptel.ac.in/noc18_cs14/preview
6. https://www.coursera.org/specializations/data-mining
7. https://www.futurelearn.com/courses/data-mining-with-weka
8. https://docs.rapidminer.com/
9. https://archive.ics.uci.edu/ml/datasets.html
10. IRIS dataset: http://archive.ics.uci.edu/ml/datasets/Iris
11. Mushroom dataset: http://archive.ics.uci.edu/ml/datasets/Mushroom
12. Breast cancer dataset: http://archive.ics.uci.edu/ml/datasets/Breast+Cancer
13. Car evaluation dataset: http://archive.ics.uci.edu/ml/datasets/Car+Evaluation

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Attendance	15 Marks
4	Lab Assessment	45 Marks
	Total	100 marks

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Average
CO-1	3	2	2	1	2	3	3	2	1	3	2	1	**2.1**
CO-2	3	3	2	1	1	3	3	1	3	3	3	1	**2.3**
CO-3	3	3	2	1	2	2	2	1	3	3	3	2	**2.3**
CO-4	3	3	3	2	2	2	3	2	2	1	2	2	**2.3**
CO-5	3	3	3	3	2	3	1	2	3	2	3	3	**2.6**
Average	**3**	**2.8**	**2.4**	**1.6**	**1.8**	**2.6**	**2.4**	**1.6**	**2.4**	**2.4**	**2.6**	**1.8**	

Data Compression

COURSE CODE: 18B1WCI532

COURSE CREDITS: 2

CORE/ELECTIVE: ELECTIVE

L-T-P: 2-0-0

Pre-requisites: Digital image processing, UG mathematics, vectors, basic programming skills

Course Objectives:

1. To provide students with contemporary knowledge in Data Compression and Coding.
2. To equip students with skills to analyze and evaluate different Data Compression and Coding methods.
3. Analyze the operation of a range of commonly used Coding and Compression techniques
4. Identify the basic software and hardware tools used for data compression.
5. Identify what new trends and what new possibilities of data compression are available.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	To understand the statistical basis for and performance metrics for lossless compression.	Familiarity
CO-2	To understand the conceptual basis for commonly used lossless compression techniques	Assessment
CO-3	To understand how to use and evaluate several readily available implementations of those techniques	Assessment
CO-4	To understand the structural basis for and performance metrics for commonly used lossy compression techniques	Assessment
CO-5	To understand the conceptual basis for commonly used lossy compression techniques	Assessment
CO-6	To implement graph theory in compression methodologies for images in MATLAB	Usage
CO-7	To understand image compression techniques‟ case studies	Familiarity

Course Contents:

Unit	Contents	Lectures required
1	**Introduction**: Definitions, Historical background, Applications, Taxonomy	2
2	**Intuitive Compression:** Run-Length Encoding, RLE Text Compression, RLE Image Compression, Move-to Front Coding, Scalar Quantization	4
3	**Statistical Methods Information:** Theory Concepts, Variable- Size Codes, Prefix Codes, Golomb Codes, The Kraft-MacMillan Inequality, The Counting Argument, Shannon-Fano Coding, Huffman Coding, Adaptive Huffman Coding, MNP5, MNP7, Arithmetic coding, Adaptive Arithmetic Coding, QM Coder, Text Compression, Context-Tree Weighting	5
4	**Dictionary Methods:** String Compression, Simple Dictionary Compression, LZ77 (Sliding Window), LZSS, Repetition Times, QIC-122, LZX, File Differencing: VCDIFF, LZ78, LZFG, LZRW1,LZRW 4, LZW, LZMW, LZAP, LZY, LZP,	6

	Repetition Finder, UNIX Compression, The V.42bis Protocol, XML Compression: XMill, EXE Compressors, CRC, Data Compression Patents	
5	**Image Compression:** Approaches to Image Compression; Image Transforms, Orthogonal Transforms. The Discrete Cosine Transform JPEG, JPEG-LS. Progressive Image Compression, JBIG, JBIG2, Simple Images: EIDAC, Vector Quantization, Adaptive Vector Quantization, Block Matching, Block Truncation Coding, Context-Based Methods, FELICS, Progressive FELICS, Differential Lossless Compression	**6**
6	**Wavelet Methods:** Fourier Transform, The Frequency Domain, Fourier Image, Compression, Multiresolution Decomposition, The Laplacian Pyramid, SPIHT, CREW. EZW, DjVu, JPEG 2000	**6**
7	**Video Compression:** Analog Video , Composite and Components Video, Digital Video, Video Compression, MPEG, MPEG-4, H.261 **Audio Compression:** Sound, Digital Audio, The Human Auditory System , μ-Law and A-Law Companding, ADPCM Audio Compression, MLP Audio, Speech Compression, Shorten MPEG-1 Audio Layers	**7**
8	**Other Methods and Application:** Zip and Gzip, PNG, The Burrows-Wheeler Method, Symbol Ranking, ACB, SortBased Context Similarity, Sparse Strings, Word-Based Text Compression, Textual Image Compression, Dynamic Markov Coding, FHM Curve Compression, Sequitur, Triangle Mesh Compression: Unicode Compression	**6**
Total Lectures		**42**

Suggested Text Book(s):

1. David Salomon , A Concise Introduction to Data Compression, 1st edition, Springer, 2008
2. Sayood, Khalid, Introduction to Data Compression, 3rd Edition, Morgan Kaufmann, 2006

Suggested Reference Book(s):

1. David Salomon, G. Motta, D. Bryan, Data Compression: The Complete Reference, 4nd edition, Springer(2006)
2. D.C. Hankerson, Greg A. Harris , Peter D. Johnson Jr, Introduction to Information Theory and Data Compression, Second Edition, Chapman & Hall/CRC; 2 edition 2003
3. Anderson, J.B. and Mohan, S., Source and Channel Coding, Kluwer, 1991.
4. Gersho, A. and Gray, R.M., Vector Quantization and Signal Compression, Kluwer, 1992.

Other useful resource(s):

1. Link to NPTEL course contents: https://nptel.ac.in/courses/108104098/41
2. Link to topics related to course:
   i. https://london.ac.uk/sites/default/files/study-guides/data-compression.pdf
   ii. http://www.ws.binghamton.edu/fowler/fowler%20personal%20page/EE523.htm
   iii. http://www.nhu.edu.tw/~chun/CS-ch15-Data%20Compression.pdf
   iv. http://apachetechnology.in/ati/www/KC/dw/Saloman%20-%20Data_Compression_Complete_Reference.pdf

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2

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3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment		Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the ProgrammeOutcomes(POs)

Course Outcomes (Data Compression)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	3	1	1	3	2	3	3	3	3	1	**2.4**
CO-2	2	2	2	2	3	3	2	3	3	3	1	3	**2.4**
CO-3	3	3	3	3	3	3	3	3	3	3	3	3	**3**
CO-4	3	3	2	3	3	3	2	1	1	3	3	3	**2.5**
CO-5	3	3	3	1	2	3	2	3	3	3	3	2	**2.6**
CO-6	2	2	2	3	3	3	2	3	3	3	1	3	**2.5**
CO-7	3	3	3	3	3	3	3	3	3	3	3	3	**3**
Average	**2.7**	**2.7**	**2.6**	**2.3**	**2.6**	**3**	**2.3**	**2.7**	**2.7**	**3**	**2.4**	**2.6**	

Principles of Programming Languages

COURSE CODE: 18B1WCI533

COURSE CREDITS: 2

CORE/ELECTIVE: ELECTIVE

L-T-P: 2-0-0

Pre-requisites: Familiarity with any one of the procedural or object oriented language such as C/C++/Java is mandatory.

Course Objectives:

1. Compare programming languages.
2. Describe the main principles of imperative, functional, object oriented and logic oriented programming languages;
3. Recite the high points of programming language history.
4. Read the central formalisms used in the description of programming languages.
5. Assess programming languages critically and in a scientific manner;
6. Analyze the principles of an imperative, functional, object oriented or logic oriented programming language; and
7. Use a formalism to describe a programming language.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	To learn major programming paradigms and techniques involved in design and implementation of modern programming languages. To learn the structure of a compiler and interpretation. To learn syntax and symantic of programming language.	Familiarity
CO-2	To learn the structured and object oriented programming paradigm.	Familiarity
CO-3	To different programming paradigm to improving the clarity, quality, and development time of a program (structured programming). To learn Haskell (an advanced purely-functional programming style and lambda calculus (for variable binding and substitution).	Assessment
CO-4	To learn To understand basic logic programming through Prolog. Case study of a logic programming language – Prolog knapsack	Usage
CO-5	To learn the concurrency in programming languages, Exception handling and Scripting languages	Familiarity
CO-6	Case study of a markup language – XML. Common web development languages & technologies – XML, JavaScript, AJAX, Mashups, etc.	Assessment

Course Contents:

Unit	Contents	Lectures required
1	Introduction to the course Introduction to major programming languages History of major programming languages. Introduction to the programming language paradigms	**4**
2	Compilation and Interpretation Syntax of a programming language Programming language semantics	**5**

	Structured Programming Procedure Activations	
3	Type systems in programming languages Object oriented programming language features Java Virtual Machine	**5**
4	Introduction to functional programming paradigm Case study of a functional programming language – Haskell Introduction to the lambda calculus Introduction to logic programming paradigm Case study of a logic programming language – Prolog	**16**
5	Introduction to concurrency in programming languages Exception handling Scripting languages	**7**
6	Markup languages Case study of a markup language – XML Common web development languages & technologies XML, JavaScript, AJAX, Mashups, etc.	**4**
Total Lectures		**42**

Suggested Text Book(s):

1. Programming Languages: Concepts & Constructs, 2nd Edition by Ravi Sethi; Pearson Education Asia
2. Programming Language Principles and Paradigms 2nd Edition, Tucker, Allen B. Michael and Noonan Robert E. , TMH 2007

Suggested Reference Book(s):

1. Programming Languages and Paradigms, D. A. Watt., Prentice-Hall,1990
2. Essentials of Programming Languages, Daniel Friedman, Mitchell Wand, and Christopher Haynes, MIT Press (Indian edition - Prentice Hall, India)
3. Concepts of Programming Languages, Robert W. Sebesta, Pearson Education Asia
4. Programming Languages: Design & Implementation, Pratt & Zelkowitz, PHI Pub. (Latest Edition)
5. Programming Languages: Principles and Practices, Kenneth C. Louden, Thomson Press

Other useful resource(s):

1. https://nptel.ac.in/syllabus/106102067/
2. http://www.nptelvideos.in/2012/11/principles-of-programming-languages.html
3. https://nptel.ac.in/courses/106102067/
4. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-821-programming-languages-fall-2002/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment		Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course Outcomes (Principles of Programming Languages)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	2	3	1	2	3	2	2	1	1	1	3	**2**

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CO-2	3	2	3	1	1	3	2	3	2	1	1	3	**2.1**
CO-3	3	2	3	1	1	2	2	2	1	1	1	3	**1.8**
CO-4	3	3	3	1	1	2	2	2	1	1	1	3	**1.9**
CO-5	3	2	3	2	2	3	2	2	1	1	1	3	**2.1**
CO-6	3	2	3	2	2	3	2	2	2	1	1	3	**2.2**
Average	**3**	**2.2**	**3**	**1.3**	**1.5**	**2.7**	**2**	**2.2**	**1.3**	**1**	**1**	**3**	

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Java Programming

COURSE CODE: 18B1WCI534

COURSE CREDITS: 2

CORE/ELECTIVE: ELECTIVE

L-T-P: 2-0-0

Pre-requisites: Object-Oriented Systems and Programming

Course Objectives:

1. Using Graphics, Animations and Multithreading for designing Simulation and Game based applications.
2. Design and develop GUI applications using Abstract Windowing Toolkit (AWT), Swing and Event Handling.
3. Design and develop Web applications
4. Designing distributed applications using Remote Method Invocation (RMI)

Course Outcomes:

S. No	Course Outcomes	Level of Attainment
CO-1	To learn the graphics and animation on the web pages, using Java Applets. To learn and design a full set of Event driven UI widgets and other components, including windows, menus, buttons, checkboxes, text fields, scrollbars and scrolling lists, using Abstract Windowing Toolkit (AWT) & Swings	Usage
CO-2	To learn Java Data Base Connectivity (JDBC) so as to retrieve and manipulate the information on any relational database through Java programs.	Usage
CO-3	To learn the server side programming using Servlets and JSP.	Usage
CO-4	To learn the invocation of the remote methods in an application using RMI	Usage

Course Contents:

Unit	Contents	Lectures required
1	Applet Programming: Structure and Life Cycle of a Java Applet, Graphics, Multithreading and Animation, Abstract Windowing Toolkit, Swings and Event Handling.	8
2	Java Database Connectivity (JDBC): JDBC Product, Types of Drivers, Two- Tier Client/Server Model, Three-Tier Client/Server Model, Basic Steps of JDBC, Creating and Executing SQL Statement, The Result Set Object, Working with Database MetaData Interface.	6
3	Java Servlets: Servlet Interaction & Advanced Servlets, Life cycle of Servlet, Java Servlet Development Kit, Javax.servlet package, Reading Servlet Parameters, Reading Initialization Parameters, The javax.servlet.http Package, Handling HTTP. Java Server Pages (JSP): JSP Technologies, Understanding the Client-Server Model, Understanding Web server software, Configuring the JSP Server, Handling JSP Errors, JSP Translation Time Errors, JSP Request Time Errors, Creating a JSP Error Page, JSP with Java Bean.	10
4	Remote Method Invocation (RMI): RMI Architecture, Designing RMI application, Executing RMI application.	4
Total Lectures		**28**

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Suggested Text Book(s):

1. Java the Complete Reference, ninth edition by Herbert Schild, Publisher: McGraw Hills
2. Advanced Java Programming by Uttam K. Roy, Publisher: Oxford University Press

Suggested Reference Book(s):

1. Head First Servlets and JSP by Bryan Basham, Kathy Sierra & Bert Bates, Publisher: O'Reilly Media

Other useful resource(s):

1 Link to NPTEL course contents:
   i. http://www.nptelvideos.com/java/java_video_lectures_tutorials.php
   ii. https://nptel.ac.in/courses/106105084/28

2 Link to topics related to course:
   i. https://www.javatpoint.com/
   ii. https://www.tutorialspoint.com/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment		Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course Outcomes (Java Programming)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	2	2	1	2	2	3	1	3	1	3	**2.2**
CO-2	3	3	2	2	1	2	1	3	2	2	3	3	**2.3**
CO-3	3	3	2	3	3	3	1	3	2	3	3	2	**2.6**
CO-4	3	3	2	3	3	3	1	3	2	3	3	2	**2.6**
Average	**3**	**3**	**2**	**2.5**	**2**	**2.5**	**1.3**	**3**	**1.8**	**2.8**	**2.5**	**2.5**	

Information Theory and Coding

COURSE CODE: 18B1WCI531

COURSE CREDITS: 2

CORE/ELECTIVE: ELECTIVE

L-T-P: 2-0-0

Pre-requisites: Basic Probability Theory

Course Objectives:

1. Understand and appreciate how information theory is concerned with the fundamental limits of communication i.e. limit to data compression, and reliable communication over a noisy channel
2. Understand how coding theory is concerned with techniques to realize the limits specified by information theory, and learn the techniques of source coding and channel coding.
3. Get an idea of the broad areas where information theory is used i.e. in statistics, data analysis, cryptography, etc.,
4. Identify how development of information theory and coding theory has been crucial to the development of communications.

Course Outcomes:

S. NO	Course Outcomes	Level of Attainment
CO-1	Understand the basics of information theory and how it is concerned with the fundamental limits of communication	Familiarity
CO-2	Understand the concept of coding and compression techniques	Familiarity
CO-3	Design applications with error control	Usage
CO-4	Use Compression And Decompression Techniques.	Usage
CO-5	Construct efficient codes for data on imperfect communication channels.	Assessment
CO-6	Apply The Concepts Of Multimedia Communication	Assessment

Course Contents:

Unit	Contents	Lectures required
1	**Information Entropy Fundamentals** Uncertainty, information and entropy – source coding theorem – huffman coding – shannonfano coding – discrete memory less channels – channel capacity – channel coding theorem – channel capacity theorem.	5
2	**Data And Voice Coding** Differential pulse code modulation – adaptive differential pulse code modulation – adaptive subband coding – delta modulation – adaptive delta modulation – coding of speech signal at low bit rates (vocoders, lpc).	7
3	**Error Control Coding** Linear block codes – syndrome decoding – minimum distance consideration – cyclic codes – generator polynomial – parity check polynomial – encoder for cyclic codes – calculation of syndrome – convolutional codes.	7
4	**Compression Techniques** Adaptive Huffman Coding, Arithmetic Coding, LZW algorithm – Audio: Perceptual	7

	coding, Masking techniques, Psychoacoustic model, MEG Audio layers I,II,III, Dolby AC3 - Speech: Channel Vocoder, Linear Predictive Coding	
5	**Image And Video Coding** Image and Video Formats – GIF, TIFF, SIF, CIF, QCIF – Image compression: READ, JPEG – Video Compression: Principles- I,B,P frames, Motion estimation, Motion compensation, H.261, MPEG standard	6
Total Lectures		**32**

Suggested Text Book(s):

1. Cover, Thomas M., and Joy A. Thomas. *Elements of information theory*. John Wiley & Sons, 2012.
2. Simon Haykin, "Communication Systems", 4th Edition, John Wiley And Sons, 2001.
3. Fred Halsall, "Multimedia Communications, Applications Networks Protocols And Standards", Pearson Education, Asia 2002

Suggested Reference Book(s):

1. Bose, Ranjan. *Information theory, coding and cryptography*. Tata McGraw-Hill Education, 2008.
2. Mark Nelson, "Data Compression Book", BPB Publication 1992.
3. Watkinson J, "Compression in Video And Audio", Focal Press, London, 1995.

Other useful resource(s):

1. Link to NPTEL course contents:https://nptel.ac.in/courses/117101053/
2. Link to topics related to course:
   i. http://chamilo2.grenet.fr/inp/courses/PHELMA4PMSTHI9/document/Info_Th_ChI-II-III.pdf?cidReq=PHELMA4PMSTHI9&id_session=0&gidReq=0&origin=

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment		Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course Outcomes(Information Theory and Coding)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	2	1	2	2	2	1	2	3	3	2	**2.2**
CO-2	3	3	3	2	2	2	3	2	2	1	2	2	**2.3**
CO-3	3	3	2	1	1	3	3	3	3	3	1	1	**2.3**
CO-4	3	2	2	1	2	2	2	2	1	2	1	2	**1.8**
CO-5	3	2	2	1	2	3	3	2	1	3	2	1	**2.1**
CO-6	3	3	2	1	1	3	3	1	3	3	3	1	**2.3**
Average	**3**	**2.7**	**2.2**	**1.2**	**1.7**	**2.5**	**2.7**	**1.8**	**2**	**2.5**	**2**	**1.5**	

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Data Compression Lab

COURSE CODE: 18B1WCI572
COURSE CREDITS: 1
CORE/ELECTIVE: ELECTIVE
L-T-P: 0-0-2

Pre-requisite: None

Course Objectives:

1. To provide students with contemporary knowledge in Data Compression and Coding.
2. To equip students with skills to analyze and evaluate different Data Compression and Coding methods.
3. Analyze the operation of a range of commonly used Coding and Compression techniques
4. Identify the basic software and hardware tools used for data compression.
5. Identify what new trends and what new possibilities of data compression are available.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	To understand the statistical basis for and performance metrics for lossless compression.	Familiarity
CO-2	To understand the conceptual basis for commonly used lossless compression techniques	Assessment
CO-3	To understand how to use and evaluate several readily available implementations of those techniques	Assessment
CO-4	To understand the structural basis for and performance metrics for commonly used lossy compression techniques	Assessment
CO-5	To understand the conceptual basis for commonly used lossy compression techniques	Assessment
CO-6	To implement graph theory in compression methodologies for images in MATLAB	Usage
CO-7	To understand image compression techniques‟ case studies	Familiarity

List of Experiments:

S. No	Description	Hours
1	Implementing a Huffman decoder	**2**
2	Implementing a Huffman encoder	**2**
3	Compressing a large file	**2**
4	Implementation of Run-Length Encoding	**2**
5	Implementation of RLE Text Compression	**2**
6	Implementation of RLE Image Compression	**2**
7	Implementation of Move-toFront Coding	**2**
8	Implementation of Scalar Quantization	**2**
9	Implementing Variable-Size Codes	**2**
10	Implementing Prefix Codes	**2**

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11	Implementing Golomb Codes	**2**
12	Implementing The Kraft-MacMillan Inequality	**2**
13	Implementing The Counting Argument	**2**
14	Implementing Shannon-Fano Coding	**2**
Total Lab hours		**28**

Minor Project(s) – (Only for 2 credit lab)

1. Image Compression using Filtering Techniques.
2. Image Decopression using Wavelets transform.
3. Compressing dehazed images using HE, Fattal method
4. Underwater Image compression using Wavelets and equalization
5. Underwater Panoramic Image compression using mosaicking techniques

Suggested Books/Resources:

1. David Salomon , A Concise Introduction to Data Compression, 1st edition, Springer, 2008
2. Sayood, Khalid, Introduction to Data Compression, 3rd Edition, Morgan Kaufmann, 2006
3. David Salomon, G. Motta, D. Bryan, Data Compression: The Complete Reference, 4nd edition, Springer(2006)
4. D.C. Hankerson, Greg A. Harris , Peter D. Johnson Jr, Introduction to Information Theory and Data Compression, Second Edition, Chapman & Hall/CRC; 2 edition 2003
5. Anderson, J.B. and Mohan, S., Source and Channel Coding, Kluwer, 1991.
6. Gersho, A. and Gray, R.M., Vector Quantization and Signal Compression, Kluwer, 1992.
7. Link to NPTEL course contents: https://nptel.ac.in/courses/108104098/41
8. Link to topics related to course:
   i. https://london.ac.uk/sites/default/files/study-guides/data-compression.pdf
   ii. http://www.ws.binghamton.edu/fowler/fowler%20personal%20page/EE523.htm
   iii. http://www.nhu.edu.tw/~chun/CS-ch15-Data%20Compression.pdf
   iv. http://apachetechnology.in/ati/www/KC/dw/Saloman%20-%20Data_Compression_Complete_Reference.pdf

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Attendance	15 Marks
4	Lab Assessment	45 Marks
	Total	100 marks

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Average
CO-1	3	3	3	1	2	3	2	3	3	3	3	2	**2.6**
CO-2	2	2	2	3	3	3	2	3	3	3	1	3	**2.5**
CO-3	3	3	3	3	3	3	3	3	3	3	3	3	**3**

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CO-4	3	3	2	3	3	3	2	1	1	3	3	3	**2.5**
CO-5	3	3	3	1	2	3	2	3	3	3	3	1	**2.5**
CO-6	2	2	2	3	3	3	2	3	3	3	1	3	**2.5**
CO-7	3	3	3	3	3	3	3	3	3	3	3	3	**3**
Average	**2.7**	**2.7**	**2.6**	**2.4**	**2.7**	**3**	**2.3**	**2.7**	**2.7**	**3**	**2.4**	**2.6**	

Approved in Academic Council held on 25.10.2018

Principles of Programming Languages Lab

COURSE CODE: 18B1WCI573

COURSE CREDITS: 1

CORE/ELECTIVE: ELECTIVE

L-T-P: 0-0-2

Pre-requisite: None

Course Objectives:

1. Learn syntax, semantics and create Functions in Principles of Programming Languages.
2. Recite the high points of programming language history.
3. Read the central formalisms used in the description of programming languages.
4. Assess programming languages critically and in a scientific manner;
5. Analyze the principles of an imperative, functional, object oriented or logic oriented programming language.

Course Outcomes:

S. NO	Course Outcomes	Level of Attainment
CO-1	To learn major programming paradigms and techniques involved in design and implementation of modern programming languages. To learn the structure of a compiler and interpretation. To learn syntax and semantic of programming language.	Familiarity
CO-2	To learn the structured and object oriented programming paradigm.	Familiarity
CO-3	To different programming paradigm to improving the clarity, quality, and development time of a program (structured programming). To learn Haskell (an advanced purely-functional programming style and lambda calculus (for variable binding and substitution).	Assessment
CO-4	To learn the concurrency in programming languages, Exception handling and Scripting languages	Familiarity

List of Experiments:

S. No	Description	Hours
1	1. To understand the value of records in a programming language, write a small program in a C-based language that uses an array of structs that store student information, including name, age, GPA as a float, and grade level as a string (e.g., “freshmen,” etc.). Also, write the same program in the same language without using structs. 2. To understand the value of recursion in a programming language, write a program that implements quicksort, first using recursion and then without recursion.	**2**

	1. Write a BNF description of the Boolean expressions of Java, including the three operators && || and ! and the relational expressions.
	2. Prove the following program is correct: a. {n >
	0}
	b. count = n;
	c. sum = 0;
	d. while
	e. count <> 0
	f. do
	g. sum = sum + count;
	h. count = count - 1;
	i. end
	j. {sum = 1 + 2 + ...+ n}
		2

3	**1.** Implement and test the LR parsing algorithm [Hint Section 4.5.3 page 214 book concepts-of-programming-languages]	**2**
4	**1.** Write a C function that includes the following sequence of statements: *x = 21;* *int x;* *x = 42;* Run the program and explain the results. Rewrite the same code in C++ and Java and compare the results. **2.** Write three functions in C or C++: one that declares a large array statically, one that declares the same large array on the stack, and one that creates the same large array from the heap. Call each of the subprograms a large number of times (at least 100,000) and output the time required by each. Explain the results	**2**
5	**1.** Write a program in the language of your choice that behaves differently if the language used name equivalence than if it used structural equivalence.. **2.** Write a Java program that exposes Java‟s rule for operand evaluation order when one of the operands is a method call.	**2**
6	**1.** Rewrite the following code segment using a multiple-selection statement in the following languages: *if* *((k == 1) || (k == 2)) j = 2 * k - 1 if* *((k == 3) || (k == 5)) j = 3 * k + 1 if* *(k == 4) j = 4 * k - 1 if* *((k == 6) || (k == 7) || (k == 8)) j = k – 2* *a. Fortran 95 (you'll probably need to look this one up)* *b. Ada* *c. C, C++, Java, or C#* *d. Python* *e. Ruby* Assume all variables are integer type. Discuss the relative merits of the use of these languages for this particular code.	**2**
7	**1.** Write a Perl program that passes by reference a literal to a subprogram, which attempts to change the parameter. Given the	**2**

	overall design philosophy of Perl, explain the results. **2.** Write a program in some language that has both static and stack dynamic local variables in subprograms. Create six large (at least 100*100) matrices in the subprogram three static and three stack dynamic. Fill two of the static matrices and two of the stack-dynamic matrices with random numbers in the range of 1 to 100. The code in the subprogram must perform a large number of matrix multiplication operations on the static matrices and time the process. Then it must repeat this with the stack-dynamic matrices. Compare and explain the results **3.** Write a generic Ada function that takes an array of generic elements and a scalar of the same type as the array elements. The type of the array elements and the scalar is the generic parameter. The subscripts of the array are positive integers. The function must search the given array for the given scalar and return the subscript of the scalar in the array. If the scalar is not in the array, the function must return –1 . Instantiate the function for Integer and Float types and test both.	
8	**1.** Write a program that includes two subprograms, one that takes a single parameter and performs some simple operation on that parameter and one that takes 20 parameters and uses all of the parameters, but only for one simple operation. The main program must call these two subprograms a large number of times. Include in the program timing code to output the run time of the calls to each of the two subprograms. Run the program on a RISC machine and on a CISC machine and compare the ratios of the time required by the two subprograms. Based on the results, what can you say about the speed of parameter passing on the two machines?	**2**
9	**1.** Write an abstract data type for queues whose elements store 10- character names. The queue elements must be dynamically allocated from the heap. Queue operations are enqueue, dequeue, and empty. Use either Ada, C++, Java, C#, or Ruby. **2.** Write an abstract data type for rational numbers (a numerator and a denominator). Include a constructor and methods for getting the numerator, getting the denominator, addition, subtraction, multiplication, division, equality testing, and display. Use Java, C#, C++, Ada, or Ruby.	**2**
10	**1.** Design and implement a C++ program that defines a base class A, which has a subclass B, which itself has a subclass C. The A class must implement a method, which is overridden in both B and C. You must also write a test class that instantiates A, B, and C and includes three calls to the method. One of the calls must be statically bound to A‟s method. One call must be dynamically bound to B‟s method, and one must be dynamically bound to C‟s method. All of the method calls must be through a pointer to class A. **2.** The reader-writer problem can be stated as follows: A shared memory location can be concurrently read by any number of tasks, but when a task must write to the shared memory location, it must have exclusive access. Write a Java program for the reader-writer problem.	**2**
11	**1.** Write a Java program that inputs a list of integer values in the range of - 100 to 100 from the keyboard and computes the sum of the squares of the input values. This program must use exception handling to ensure that the input values are in range and are legal	**2**

	integers, to handle the error of the sum of the squares becoming larger than a standard Integer variable can store, and to detect end- of-file and use it to cause the output of the result. In the case of overflow of the sum, an error message must be printed and the program terminated.	
12	**1.** Write a Scheme function that computes the real roots of a given quadratic equation. If the roots are complex, the function must display a message indicating that. This function must use an *IF* function. The three parameters to the function are the three coefficients of the qua dratic equation.	**2**
13	**1.** Write a Scheme function that takes a list as a parameter and returns a list identical to the parameter list except with the second top-level element removed. If the given list does not have two elements, the function should return (). Rewrite the following Scheme function as a tail-recursive function: *(DEFINE (doit n) (IF (= n 0)* *0* *(+ n (doit (− n 1)))* *))*	**2**
14	***1.*** Using the structures *parent(X, Y)* , *male(X)* , and *female(X)* , write a structure that defines *mother(X, Y)* **2.** Write a Prolog program that succeeds if the intersection of two given list parameters is empty. **3.** Write a Prolog program that implements quicksort.	**2**
Total Lab Hours		**28**

Suggested Books/Resources:

1. https://cs444pnu1.files.wordpress.com/2014/02/concepts-of-programming-languages-10th-sebesta.pdf
2. Principles of Programming Languages: Design, Evaluation, and Implementation 3rd Edition by Bruce J. MacLennan
3. Programming Languages: Concepts & Constructs, 2nd Edition by Ravi Sethi; Pearson Education Asia
4. Programming Language Principles and Paradigms 2nd Edition, Tucker, Allen B. Michael and Noonan Robert E. , TMH 2007
5. Programming Languages and Paradigms, D. A. Watt., Prentice-Hall,1990
6. Essentials of Programming Languages, Daniel Friedman, Mitchell Wand, and Christopher Haynes, MIT Press (Indian edition - Prentice Hall, India)
7. Concepts of Programming Languages, Robert W. Sebesta, Pearson Education Asia
8. https://nptel.ac.in/courses/106102067/
9. https://www.cs.bgu.ac.il/~ppl162/Assignments

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Attendance	15 Marks
4	Lab Assessment	45 Marks
	Total	100 marks

Approved in Academic Council held on 25.10.2018

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Average
CO-1	3	2	3	1	2	3	2	2	1	1	1	3	**2**
CO-2	3	2	3	1	1	3	2	3	2	1	1	3	**2.1**
CO-3	3	2	3	1	1	2	2	2	1	1	1	3	**1.8**
CO-4	3	2	3	2	2	3	2	2	1	1	1	3	**2.1**
Average	**3**	**2**	**3**	**1.3**	**1.5**	**2.8**	**2**	**2.3**	**1.3**	**1**	**1**	**3**	

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Java Programming Lab

COURSE CODE: 18B1WCI574

COURSE CREDITS: 1

CORE/ELECTIVE: ELECTIVE

L-T-P: 0-0-2

Pre-requisite: None

Course Objectives:

1. Using Graphics, Animations and Multithreading for designing Simulation and Game based applications.
2. Design and develop GUI applications using Abstract Windowing Toolkit (AWT), Swing and Event Handling.
3. Design and develop Web applications
4. Designing distributed applications using Remote Method Invocation (RMI)

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	To learn the graphics and animation on the web pages, using Java Applets. To learn and design a full set of Event driven UI widgets and other components, including windows, menus, buttons, checkboxes, text fields, scrollbars and scrolling lists, using Abstract Windowing Toolkit (AWT) & Swings	Usage
CO-2	To learn Java Data Base Connectivity (JDBC) so as to retrieve and manipulate the information on any relational database through Java programs.	Usage
CO-3	To learn the server side programming using Servlets and JSP.	Usage
CO-4	To learn the invocation of the remote methods in an application using RMI	Usage

List of Experiments:

S. No.	Description	Hours
1	Design an applet to continuously scroll a string from the right to the left of the applet window.	**2**
2	Design an applet called Checker in which a black oval moves from a green square to a blue square. To reduce the flickering override the update method to clear only that part of the screen that is changing during the animation.	**2**
3	Write a swing-based GUI to create a tabbed pane with two tabs: Table and Tree. The first tab contains a table displaying the information of Employee {empid, ename, age}. The second tab contains a tree structure. Insert both JTable and JTree in JScrollPane. JScrollPane has to be inserted at the centre of the BorderLayout manager (with panels). When user clicks on any node of the tree, its path should be displayed on the TextField.	**2**
4	Consider a table Bank {account_no, customer_name, balance, phone_no, and address}. Write a database application which allows insertion, updation and deletion of records in the Bank table. Print values of all customers whose balance is less than 5,000.	**2**
5	User enters the name and password through an HTML form. Both these parameters are being passed to the Servlet1. The Servlet1 after retrieving the parameters generates a Cookie with username being stored in the cookie. The Servlet1 generates an HTML form, which is linked to the Servlet2. Along with the response object, the Cookie is stored permanently on the client‟s hard disk. The same user then submits the form to invoke the Servlet2. The Servlet2 must have the provision to access and display the	**2**

	cookie name. Modify the above program to use the concept of Hidden form field, instead of Cookie.	
6	Write a Servlet to validate the username and password entered by the user. If the username and password are ***„abc' and 'def'*** respectively, the Sevlet should forward the request to ***WelcomeServlet***; otherwise, it should display an error message: "*Incorrect username or password!"*	**2**
7	Write a Servlet that connects to the database (MySql) and creates a table ***emp*** with the following schema: ***emp***{empid char(5) Primary Key, ename varchar2 not null , age number(2) not null, salary number(7, 2) , address varchar2};	**2**
8	• Write a Servlet that connects to the database (MySql), runs a query to retrieve the ***ids*** and ***names*** of the ***emp*** table and displays the list to the client. • Write a Servlet to insert data into a table, using ***executeUpdate()*** and then display the result using ***executeQuery()*** Modify the above ***Servlet*** to insert the data into the ***emp*** table, using ***PreparedStatement*** interface	**2**
9	Write a JSP program to display your brief profile including your image, date of birth, address, and educational qualification. Do proper formatting and coloring of this web page.	**2**
10	Write an online phone directory based application using JSP and JDBC. Use the following table to store the phone details: Directory{phone_no, first_name, last_name, address}. The application should have the search facility on all the fields.	**2**
11	Write a JSP program using Java Bean to register users into a web-site. The registration details of users are kept in USER table with attributes as userid varchar2(10), username varchar2(15), and email_id varchar2(15).	**2**
12	Write a distributed application using RMI where a user running an application on the client"s JVM invokes a remote method String getName(String) running on the server"s JVM. After invoking this method, the name entered by the user is displayed on the client"s application.	**2**
13	Write an RMI application where client sends empno and server returns corresponding salary by querying database	**2**
14	Write one RMI application for banking to perform the deposit and withdrawal operations by client.	**2**
Total Lab hours		**28**

Suggested Books/Resources:

1. Java the Complete Reference, ninth edition by Herbert Schild, Publisher: McGraw Hills
2. Advanced Java Programming by Uttam K. Roy, Publisher: Oxford University Press
3. Head First Servlets and JSP by Bryan Basham, Kathy Sierra & Bert Bates, Publisher: O'Reilly Media
4. Link to topics related to course:
   - **i.** http://www.nptelvideos.com/java/java_video_lectures_tutorials.php
   - **ii.** https://nptel.ac.in/courses/106105084/28
   - **iii.** https://www.javatpoint.com/
   - **iv.** https://www.tutorialspoint.com/

Evaluation Scheme

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Attendance	15 Marks

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4	Lab Assessment	45 Marks
	Total	100 marks

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Average
CO-1	3	3	2	2	1	1	2	3	1	3	2	3	**2.2**
CO-2	3	3	2	2	1	1	1	3	2	2	3	3	**2.2**
CO-3	3	3	2	3	3	3	1	3	2	3	3	2	**2.6**
CO-4	3	3	2	3	3	3	1	3	2	3	3	2	**2.6**
Average	**3**	**3**	**2**	**2.5**	**2**	**2**	**1.3**	**3**	**1.8**	**2.8**	**2.8**	**2.5**	

Information Theory and Coding Lab

COURSE CODE: 18B1WCI571

COURSE CREDITS: 1

CORE/ELECTIVE: ELECTIVE

L-T-P: 0-0-2

Pre-requisite: None

Course Objectives:

1. To develop skills for designing programs on different coding techniques.
2. Understand how coding theory is concerned with techniques to realize the limits specified by information theory, and learn the techniques of source coding and channel coding.
3. Get an idea of the broad areas where information theory is used i.e. in statistics, data analysis, cryptography, etc.,
4. Identify how development of information theory and coding theory has been crucial to the development of communications.

Course Outcomes:

S. NO	Course Outcomes	Level of Attainment
CO-1	Understand the basics of information theory and how it is concerned with the fundamental limits of communication	Familiarity
CO-2	Design and implement concept of coding and compression techniques	Familiarity
CO-3	Design applications with error control	Usage
CO-4	Design and implement Compression And Decompression Techniques.	Usage
CO-5	Construct and implement efficient codes for data on imperfect communication channels.	Assessment
CO-6	Design and use the concepts Of Multimedia Communication	Assessment

List of Experiments:

S. No.	Description	Hours
1	Write a program for determination of various entropies and mutual information of a given channel. Test various types of channel such as a) Noise free channel. b) Error free channel c) Binary symmetric channel d) Noisy channel Compare channel capacity of above channels.	**2**
2	Write a Program to implement an algorithm for Determination of Entropy, Information, and Information Rate.	**2**
3	Write a program for generation and evaluation of variable length source coding using Shannon – Fano coding and decoding	**2**
4	Write a program for generation and evaluation of variable length source coding using Huffman Coding and decoding	**2**
5	Write a Program for coding & decoding of Linear block codes.	**2**
6	Write a Program for coding & decoding of Cyclic codes.	**2**
7	Write a program for coding and decoding of Convolutional codes.	**2**
8	Write a program for coding and decoding of BCH codes.	**2**
9	Write a program for coding and decoding of RS codes.	**2**

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10	Write a program to study performance of a coded and uncoded communication system(Calculate the error probability)	**2**
11	Write a simulation program to implement source coding and channel coding for transmitting a text file.	**2**
12	Write a program to implement adaptive Huffman coding to compress the textual data.	**2**
13	Write a program to implement LZW technique to compress the textual data.	**2**
14	Write a program to implement perceptual coding technique to compress audio data.	**2**
Total Lab Hours		**28**

Suggested Books/Resources:

1. Cover, Thomas M., and Joy A. Thomas. *Elements of information theory*. John Wiley & Sons, 2012.
2. Simon Haykin, "Communication Systems", 4th Edition, John Wiley And Sons, 2001.
3. Fred Halsall, "Multimedia Communications, Applications Networks Protocols And Standards", Pearson Education, Asia 2002
4. Bose, Ranjan. *Information theory, coding and cryptography*. Tata McGraw-Hill Education, 2008.
5. Mark Nelson, "Data Compression Book", BPB Publication 1992.
6. Watkinson J, "Compression in Video And Audio", Focal Press, London, 1995.
7. Link to NPTEL course contents:https://nptel.ac.in/courses/117101053/
8. Link to topics related to course:
   i. http://chamilo2.grenet.fr/inp/courses/PHELMA4PMSTHI9/document/Info_Th_ChI-II-III.pdf?cidReq=PHELMA4PMSTHI9&id_session=0&gidReq=0&origin=

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Attendance	15 Marks
4	Lab Assessment	45 Marks
	Total	100 marks

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Average
CO-1	3	3	2	2	2	2	2	1	2	3	3	1	**2.2**
CO-2	3	1	3	2	2	2	3	2	2	3	2	2	**2.3**
CO-3	3	3	2	1	1	3	3	3	3	3	1	1	**2.3**
CO-4	3	2	2	2	2	2	2	2	1	2	1	1	**1.8**
CO-5	3	3	2	1	2	3	3	2	1	2	2	1	**2.1**
CO-6	3	3	2	1	1	3	3	1	3	3	3	1	**2.3**
Average	**3**	**2.5**	**2.2**	**1.5**	**1.7**	**2.5**	**2.7**	**1.8**	**2**	**2.7**	**2**	**1.2**	

Digital Filter Design and Applications

COURSE CODE: 18B1WEC631

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Signals & Systems

Course Objectives:

1. To understand the basics and practical limitations of digital filterdesign.
2. To study the digital filters applications.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Understand the basics of the digital Filters	Familiarity
CO-2	Design and analysis of the FIR filters	Usage
CO-3	Design and analysis of the IIR filters	Usage
CO-4	Understand the limitation of IIR and FIR Filters in implementation	Familiarity
CO-5	Study the applications of digital filters	Assessment

Course Contents:

S. No.	Contents	Contact Hours
1.	Introduction to Filters: Butterworth filters, Chebyshev filters, Elliptical Filters, Bessel Filters, FIR filters, IIR Filters.	10
2.	FIR Filters: One dimensional FIR filter design using rectangular window, triangular window, hamming window, dolph-chebyshev window, and Kaiser window. Two dimensional FIR filter design.	10
3	IIR Filters: One dimensional and two dimensional IIR filter design.	06
4.	Practical Considerations in implementation Coefficient Quantization in Digital Filters, Scaling in Fixed-Point Arithmetic, Quantization Noise.	04
5.	Applications of Digital Filters, Noise suppression, Enhancement of selected frequency ranges, Removal or attenuation of selected frequencies, Bandwidth limiting. Analysis of digital filters for signal and image processing using MATLAB, and LABVIEW.	12
	Total	42

Suggested Text Book(s):

1. Andreas Antoniou, Digital Filters: Analysis, Design and Applications, Second edition, Tata Mc Graw Hill, 1999.
2. M. Ahmadi, M. Azimi-Sadjadi, R. Gorgui-Naguib, R. King, A. Kwabwe,Digital Filtering in One and Two Dimensions, 1st Edition, Springer Science & Business Media,1989.
3. Jackson, Leland B. Digital Filters and Signal Processing: with MATLAB®Exercises. Springer Science & Business Media, 2013.

Suggested Reference Book(s):

1. Wu-Sheng Lu, Two-Dimensional Digital Filters, 1st Edition, CRC Press,2001.
2. Winder, Steve, Analog and digital filter design, 2nd Edition, Newness Publishers, 2002
3. Schaumann, Rolf, Haiqiao Xiao, and Van V. Mac. "Design of Analog Filters 2nd Edition (The Oxford Series in Electrical and Computer Engineering)." (2009).
4. C. Britton Rorabaugh, "Digital Filter Designer's Handbook: With C++ Algorithms",2nd,Volume1, McGraw-Hill, 1997
5. Jolyon M.DeFreitas, Digital Filter Design and solutions, Artech house publishers, 2005

6. Andreas Antoniou, Digital Filters: Analysis, Design and Applications, Second edition, Tata Mc Graw Hill, 1999
7. Taylor, Fred. Digital filters: principles and applications with MATLAB. Vol. 30. John Wiley & Sons, 2011.

Other useful resource(s):

1. https://ocw.mit.edu/resources/res-6-008-digital-signal-processing-spring-2011/video-lectures/lecture-17-design-of-fir-digital-filters/, I Prof. Alan V. Oppenheim
2. http://web.stanford.edu/class/archive/ee/ee264/ee264.1072/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Digital Filter Design and Applications)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	3	2	2	1	1	1	1	3	1	1	1.8
CO-2	3	3	3	3	3	1	1	1	2	2	2	2	2.2
CO-3	3	3	3	3	3	1	1	1	2	2	2	3	2.3
CO-4	3	3	3	3	3	3	3	3	3	2	2	2	2.8
CO-5	3	3	3	3	3	3	3	3	3	2	2	1	2.7
Average	3	3	3	2.8	2.8	1.8	1.8	1.8	2.2	2.2	1.8	1.8	

Digital Image Processing

COURSE CODE: 18B1WCI636

COURSE CREDITS: 2

CORE/ELECTIVE: ELECTIVE

L-T-P: 2-0-0

Pre-requisites: Linear algebra, Matrices, Matrix Operations, Determinants, Systems of Linear Equations, Eigen values, Eigenvectors, Statistics and probability, Programming experience, preferably in matlab, and/or C/C++/C#/Python/Java

Course Objectives:

1. Introduction to various image processing techniques.
2. Learning the basics of Image fundamentals, describing the main characteristics of digital images and how they are represented.
3. Learning of mathematical transforms such as such as Fourier, Cosine transforms, Singular value decomposition.
4. Understanding the concepts of 2D Wavelet transform, image enhancement techniques, Image restoration and denoising, segmentation.
5. Discussing and understanding the concepts of lossy and lossless data compression algorithms, binary and color image processing.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	To learn the basic concepts and terminology in digital Image Processing.	Familiarity
CO-2	To learn about image transformation techniques and issues related to image transformation.	Assessment
CO-3	To learn the basic techniques for Image Compression	Assessment
CO-4	To learn about enhancing images through techniques like filtering and equalization	Assessment
CO-5	To learn about image restoration, segmentation and denoising.	Assessment
CO-6	To implement graph theory in vector space models and colouring methodologies for images in MATLAB	Usage
CO-7	To understand image processing techniques‟ case studies	Familiarity

Course Contents:

Unit	Contents	Lectures required
1	**Introduction to Digital Image Processing** Introduction to images and its processing, Components of image processing systems, image representations, Image file formats, Applications of digital image processing, image sampling and quantization, Image Analysis, Intensity transformations, contrast stretching, Correlation and convolution, Smoothing filters, sharpening filters, gradient and Laplacian.	5
2	**Image Transformation Techniques** Need for transform, Fourier, Cosine transforms, Haar, KL Transform, Singular value decomposition, 2D Wavelet transform,	8

	Different properties of image transform techniques.	
3	**Image Compression Basics** Concept of image compression, lossless techniques (Huffman Coding, Arithmetic and Lempel-Ziv Coding, Other Coding Techniques) and lossy compression techniques (Transform Coding & K-L Transforms, Discrete Cosine Transforms, and BTC), Multi-Resolution Analysis, and Still Image Compression Standards (JBIG and JPEG),	**8**
4	**Image Enhancement** Enhancement in spatial and transform domain, histogram equalization Directional Smoothing, Median, Geometric mean, Harmonic mean, Contraharmonic mean filters, Homomorphicfiltering,Color image enhancement.	**5**
5	**Image Restoration and Denoising** Image degradation, Type of image blur, Classification of image restoration techniques, ,image restoration model, Linear and non linear restoration techniques, Image denoising, Median filtering	**5**
6	**Image Segmentation** Classification of image segmentation techniques, Boundary detection based techniques, Point, line detection, Edge detection, Edge linking, local processing, regional processing, Hough transform, Thresholding, Iterative thresholding, Otsu's method, Moving averages, Multivariable thresholding, Region- based segmentation, Watershed algorithm, Use of motion in segmentation	**6**
Total lectures		**32**

Suggested Text Book(s):

1. Digital Image Processing, R.C. Gonzalez and R.E. Woods, 2nd edition, Pearson Prentice Hall, 2008.
2. Anil K. Jain, Fundamentals of Digital Image Processing, Prentice Hall, 1989.

Suggested Reference Book(s):

1. Digital Image processing, S Jayaraman, TMH, 2012
2. William K. Pratt, *Digital Image Processing*, 3rd Edition, John Wiley, 2001.

Other useful resource(s):

1. Link to NPTEL course contents:https://onlinecourses.nptel.ac.in/noc18_ee40/preview
2. Link to topics related to course:
   i. https://nptel.ac.in/courses/117105079/1
   ii. https://nptel.ac.in/courses/117105079/6
   iii. https://nptel.ac.in/courses/117105079/3
   iv. https://nptel.ac.in/courses/117105079/10
   v. https://nptel.ac.in/courses/117105079/12

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment		Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Approved in Academic Council held on 25.10.2018

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Digital Image Processing)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	3	1	1	3	2	3	3	3	3	2	**2.5**
CO-2	2	2	2	3	3	3	2	3	3	3	1	3	**2.5**
CO-3	3	3	3	3	3	3	3	3	3	3	3	3	**3**
CO-4	3	3	2	3	3	3	2	1	1	1	3	3	**2.3**
CO-5	3	3	3	1	2	3	2	3	3	1	3	2	**2.4**
CO-6	2	2	2	3	3	3	2	3	3	1	1	3	**2.3**
CO-7	3	3	3	3	3	3	3	3	3	1	3	3	**2.8**
Average	**2.7**	**2.7**	**2.6**	**2.4**	**2.6**	**3**	**2.3**	**2.7**	**2.7**	**1.9**	**2.4**	**2.7**	

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4. Kai Hwang and Zhiwei Xu. Scalable Parallel Computing, McGraw Hill (1998), ISBN 0-07-031798-4.
5. Michael J. Quinn. Parallel Programming in C with MPI and OpenMP, McGraw Hill (2003), ISBN 0-07-282256-2.
6. Barry Wilkinson and Michael Allen. Parallel Programming: Techniques and Applications Using Networked Workstations and Parallel Computers (2nd Edition), Prentice Hall PTR (2005), ISBN 0-13-140563-2
7. Link to NPTEL course contents: https://nptel.ac.in/courses/106102114/
8. Link to topics related to course: https://nptel.ac.in/courses/106106107/
   i. https://nptel.ac.in/courses/106106112/
   ii. https://nptel.ac.in/courses/106106112/2
   iii. https://nptel.ac.in/courses/106106112/3
   iv. https://nptel.ac.in/courses/106106112/3

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Attendance	15 Marks
4	Lab Assessment	45 Marks
	Total	100 marks

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	Average
CO1	3	3	3	3	2	2	1	1	1	1	1	1	**1.9**
CO2	3	3	3	3	3	1	1	1	1	1	1	3	**2**
CO3	3	3	2	3	2	3	2	1	1	1	2	1	**2**
CO4	3	3	3	2	3	2	1	1	1	1	1	1	**1.8**
CO5	2	2	3	3	3	3	1	1	1	1	1	1	**1.8**
CO6	2	3	3	3	2	2	2	2	2	2	2	2	**2.3**
Average	**2.7**	**2.8**	**2.8**	**2.8**	**2.5**	**2.2**	**1.3**	**1.2**	**1.2**	**1.2**	**1.3**	**1.6**	

Digital Image Processing Lab

Approved in Academic Council held on 25.10.2018

COURSE CODE: 18B1WCI676

COURSE CREDITS: 1

CORE/ELECTIVE: ELECTIVE

L-T-P: 0-0-2

Pre-requisite: None

Course Objectives:

1. Introduction to various image processing techniques.
2. Implementing the basics of Image fundamentals, describing the main characteristics of digital images and how they are represented.
3. Learning and implementing mathematical transforms such as such as Fourier, Cosine transforms Singular value decomposition.
4. Implementing the concepts of 2D Wavelet transform, image enhancement techniques, Image restoration and denoising, segmentation.
5. Discussing and implementing the concepts of lossy and lossless data compression algorithms, binary and color image processing.

Course Outcomes :

S. No.	Course Outcomes	Level of Attainment
CO-1	To learn the basic concepts and terminology in digital Image Processing.	Familiarity
CO-2	To learn about image transformation techniques and issues related to image transformation.	Assessment
CO-3	To learn the basic techniques for Image Compression	Assessment
CO-4	To learn about enhancing images through techniques like filtering and equalization	Assessment
CO-5	To learn about image restoration, segmentation and denoising.	Assessment
CO-6	To implement graph theory in vector space models and colouring methodologies for images in MATLAB	Usage
CO-7	To understand image processing techniques‟ case studies	Familiarity

List of Experiments:

S. No	Description	Hours
1	Implementing images colorizations	**1**
2	Implement various techniques for quantization	**1**
3	Implement filtering techniques	**1**
4	Transform images using Laplacian	**2**
5	Decompose images using cosine, discrete transformation	**1**
6	Implementing lossless compression techniques	**2**
7	Implementing Lossy compression methods	**1**
8	Implementing image enhancement using filtering	**2**
9	Implementing image enhancement using spatial domains	**1**
10	Implementing image enhancement using equalization techniques	**2**
11	Implementing enhancements using mean, median, geometric mean, harmonic mean	**2**
12	Implementing Contraharmonic mean filters, Homomorphic filtering	**2**
13	Implementing image restoration techniques	**1**
14	Implementing denoising techniques	**1**

Data Mining and Data Warehousing

COURSE CODE: 18B1WCI635

COURSE CREDITS: 2

CORE/ELECTIVE: ELECTIVE

L-T-P: 2-0-0

Pre-requisites: Data Structures, Compilers, Operating Systems, Computer Networks, Machine Learning and Genetic Algorithms.

Course Objective:

1. To describe the concept of Data warehouse & its attributes
2. To study different data warehouse models, architectures and implementation
3. To understand the basic concept of data mining and its functionality
4. To understand the concept of classification techniques and its implementation
5. To understand the concept of association rules, different techniques and implementation details
6. To understand the concept of cluster analysis, anomaly detection and its usage and implementation details

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	To describe the concept of Data warehouse & its attributes	Assessment
CO-2	To study different data warehouse models, architectures and implementation	Assessment
CO-3	To understand the basic concept of data mining and its functionality	Assessment
CO-4	To understand the concept of classification techniques and its implementation	Assessment
CO-5	To understand the concept of association rules, different techniques and implementation details	Assessment
CO-6	To understand the concept of cluster analysis, anomaly detection and its usage and implementation details	Usage

Course Contents:

Unit	Contents	Lectures required
1	**Introduction:** Concepts of Data Warehouse and Data Mining including its functionalities, stages of Knowledge discovery in database(KDD) , Setting up a KDD environment, Issues in Data Warehouse and Data Mining, Application of Data Warehouse and Data Mining	5
2	**Architecture:** DBMS vs. Data Warehouse, Data marts, Metadata, Multidimensional data model, Data Cubes, Schemas for Multidimensional Database: Stars, Snowflakes and Fact Constellations, Data Warehouse Architecture, Distributed and Virtual Data Warehouse, Data Warehouse Manager, OLTP, OLAP, MOLAP, HOLAP, types of OLAP, servers	6
3	**Introduction:** Data Mining, Motivation, Challenges, Origins of Data Mining, Data Mining Tasks, Data: Types of Data, Data Quality, Data Pre-processing, Measures of Similarity and Dissimilarity, Exploring Data: Iris Data Set, Summary Statistics,	3

	Visualization, OLAP and Multi dimensional Data Analysis	
4	**Classification:** Basic Concepts and Preliminaries, Approach to Solving a Classification Problem, Decision Tree Induction, Model Over fitting, Evaluating Performance of Classifier **Alternative Techniques**: Rule-Based Classifier, Nearest- Neighbour Classifiers, Artificial Neural Network (ANN), Support Vector Machine (SVM), Ensemble Methods, Class Imbalance Problem, Multiclass Problem	**6**
5	**Association Analysis:** Basic Concepts and Problem Definition, Frequent Itemset Generation, Rule Generation, Representation of Frequent Itemsets, FP-Growth Algorithm, Evaluation of Association Patterns, Handling Categorical Attributes , Handling Continuous Attributes, Handling a Concept Hierarchy, Sequential Patterns, Subgraph Patterns	**6**
6	**Cluster Analysis:** Basic Concepts, Characteristics of Data, Clusters, Partitional Clustering, Agglomerative Hierarchical Clustering, Prototype-Based Clustering, Density-Based Clustering, Graph-Based Clustering, Cluster Evaluation **Anomaly Detection:** Preliminaries, Statistical Approaches, Proximity-Based Outlier Detection, Density-Based Outlier Detection, Clustering-Based Techniques	**6**
Total lectures		**32**

Suggested Text Book(s):

1. Data Mining Concepts and Techniques J. Han and M. Kamber Morgan Kaufmann, 2006, ISBN 1-55860-901-6
2. Introduction to Data Mining Pang-Ning Tan, Michael Steinbach, Vipin Kumar, Pearson Education (Addison Wesley), 0-321-32136-7

Suggested Reference Book(s):

1. Mining Massive data sets Anand Rajaram, Jure Leskovec and Jeff Ullman Cambridge University Press
2. https://onlinecourses.nptel.ac.in/noc18_cs14/preview
3. https://www.coursera.org/specializations/data-mining.
4. https://www.futurelearn.com/courses/data-mining-with-weka

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment		Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Data Mining and Data Warehousing)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO 1	3	2	1	2	2	2	2	2	2	1	1	2	**1.8**

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CO 2	3	3	3	3	3	3	2	3	3	1	1	3	**2.6**
CO 3	3	3	3	3	2	2	1	2	3	2	3	3	**2.5**
CO 4	3	1	2	1	2	1	1	2	1	2	2	2	**1.7**
CO 5	3	3	3	3	2	3	1	2	3	2	3	3	**2.6**
CO 6	3	2	1	2	2	1	2	2	2	1	1	2	**1.8**
Average	**3**	**2.3**	**2.2**	**2.3**	**2.2**	**2**	**1.5**	**2.2**	**2.3**	**1.5**	**1.8**	**2.5**	

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Data Warehouse and Data Mining Lab

COURSE CODE: 18B1WCI675

COURSE CREDITS: 1

CORE/ELECTIVE: ELECTIVE

L-T-P: 0-0-2

Pre-requisite: Introduction to Programming

Course Objectives:

1. Practical exposure on implementation of well known data mining tasks.
2. Exposure to real life data sets for analysis and prediction.
3. Learning performance evaluation of data mining algorithms in a supervised and an unsupervised setting.
4. Handling a small data mining project for a given practical domain.
5. Develop and apply enthusiasm for learning machine learning tools and techniques.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Practical exposure on implementation of well known data mining tasks.	Familiarity
CO-2	Exposure to real life data sets for analysis and prediction.	Technical skills
CO-3	Learning performance evaluation of data mining algorithms in a supervised and an unsupervised setting.	Computational skills
CO-4	Handling a small data mining project for a given practical domain.	Computational
CO-5	Develop and apply machine learning tools and techniques.	Assessment

List of Experiments:

S. No.	Description	Hours
1	Introduction to Rapid Miner Studio, Weka and R	**2**
2	Creation of a Data Warehouse in Rapid Miner	**2**
3	Apriori Algorithm	**4**
4	FP-Growth Algorithm	**4**
5	K-means Clustering, K-Means ++ Clustering	**4**
6	Hierarchical clustering algorithm	**4**
7	Bayesian Classification	**2**
8	Decision Tree	**2**
9	Feature Reduction using PCA	**2**
10	Model Examination	**2**
Total Lab hours		**28**

Suggested Books/Resources:

1. Introduction to Data Mining Pang-Ning Tan, Michael Steinbach, Vipin Kumar, Pearson Education (Addison Wesley), 0-321-32136-7, 2006
2. Mininig Massive data sets Anand Rajaram, Jure Leskovec and Jeff Ullman Cambridge University Press
3. Data Mining Concepts and Techniques J. Han and M. Kamber Morgan Kaufmann, 2006, ISBN 1-55860-901-6

4. An Introduction to Information Retrieval, 2008 Cambridge UP.
5. https://onlinecourses.nptel.ac.in/noc18_cs14/preview
6. https://www.coursera.org/specializations/data-mining
7. https://www.futurelearn.com/courses/data-mining-with-weka
8. https://docs.rapidminer.com/
9. https://archive.ics.uci.edu/ml/datasets.html
10. IRIS dataset: http://archive.ics.uci.edu/ml/datasets/Iris
11. Mushroom dataset: http://archive.ics.uci.edu/ml/datasets/Mushroom
12. Breast cancer dataset: http://archive.ics.uci.edu/ml/datasets/Breast+Cancer
13. Car evaluation dataset: http://archive.ics.uci.edu/ml/datasets/Car+Evaluatio

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Attendance	15 Marks
4	Lab Assessment	45 Marks
	Total	100 marks

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Average
CO-1	3	3	1	2	2	2	2	2	2	1	1	2	**1.9**
CO-2	3	3	3	3	3	3	2	3	3	1	1	3	**2.6**
CO-3	3	3	3	3	2	3	1	2	3	2	3	3	**2.6**
CO-4	3	1	2	1	2	1	1	2	1	1	1	2	**1.5**
CO-5	3	3	3	3	2	3	1	2	3	2	3	3	**2.6**
Average	**3**	**2.6**	**2.4**	**2.4**	**2.2**	**2.4**	**1.4**	**2.2**	**2.4**	**1.4**	**1.8**	**2.6**	

CO4	3	3	3	3	3	2	1	1	1	2	1	3	**2.2**
Average	**3**	**3**	**2**	**1.8**	**2.5**	**2**	**1.3**	**1**	**1**	**2**	**1.3**	**2.3**	

Data Structure and Algorithms

COURSE CODE: 18B11CI211

COURSE CREDIT: 4

CORE/ELECTIVE: CORE

: 3-1-0

Pre-requisites: C/C++

Course Objectives:

1. To impart the basic concepts of data structures and algorithms.
2. To understand concepts about searching and sorting techniques
3. To understand basic concepts about stacks, queues, lists, trees and graphs.
4. To enable them to write algorithms for solving problems with the help of fundamental data structures
5. Introduce students to data abstraction and fundamental data structures.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	To gain knowledge on the notions of data structure, Abstract Data Type.	Familiarity
CO-2	For a given algorithm student will able to analyze the algorithms to determine the time and computation complexity and justify the correctness.	Assessment
CO-3	For a given Search problem (Linear Search and Binary Search) student will able to implement it.	Assessment
CO-4	For a given problem of Stacks, Queues and linked list student will able to implement it and analyze the same to determine the time and computation complexity.	Assessment
CO-5	Student will able to implement Graph search and traversal algorithms and determine the time and computation complexity.	Assessment
CO-6	Student will able to write an algorithm Selection Sort, Bubble Sort, Insertion Sort, Quick Sort, Merge Sort, Heap Sort and compare their performance in term of Space and Time complexity.	Usage

Course Contents:

Unit	Contents	Lectures required

1	**Introduction:** Basic Terminologies: Elementary Data Organizations, Data Structure Operations: insertion, deletion, traversal etc.; Analysis of an Algorithm, Asymptotic Notations, Time-Space trade off. Searching: Linear Search and Binary Search Techniques and their complexity analysis.	**7**
2	**Stacks:** ADT Stack and its operations: Algorithms and their complexity analysis, Applications of Stacks: Expression Conversion and evaluation – corresponding algorithms and complexity analysis.	**5**
3	**Queues:** ADT queue, Types of Queue: Simple Queue, Circular Queue, Priority Queue; Operations on each types of Queues: Algorithms and their analysis.	**5**
4	**Linked Lists:** Singly linked lists: Representation in memory, Algorithms of several operations: Traversing, Searching, Insertion into, Deletion from linked list; Linked representation of Stack and Queue, Header nodes, Doubly linked list: operations on it and algorithmic analysis; Circular Linked Lists: all operations their algorithms and the complexity analysis.	**8**
5	**Trees:** Basic Tree Terminologies, Different types of Trees: Binary Tree, Threaded Binary Tree, Binary Search Tree, AVL Tree; Tree operations on each of the trees and their algorithms with complexity analysis. Applications of Binary Trees. B Tree, B+ Tree: definitions, algorithms and analysis.	**6**
6	**Sorting and Hashing:** Objective and properties of different sorting algorithms: Selection Sort, Bubble Sort, Insertion Sort, Quick Sort, Merge Sort, Heap Sort; Performance and Comparison among all the methods, Hashing.	**6**
7	**Graph:** Basic Terminologies and Representations, Graph search and traversal algorithms and complexity analysis.	**5**
Total lectures		**42**

Suggested Text Book(s):

1. "Fundamentals of Data Structures", Illustrated Edition by Ellis Horowitz, Sartaj Sahni, Computer Science Press

Suggested Reference Book(s):

1. "Algorithms, Data Structures, and Problem Solving with C++", Illustrated Edition by Mark Allen Weiss, Addison-Wesley Publishing Company
2. "How to Solve it by Computer", 2nd Impression by R. G. Dromey, Pearson Education.
3. "Data structures and Algorithms Made Easy" 5th edition by Narasimha Karumanchi, Career monk publications
4. "Data Structure and Algorithms in C" 2nd edition by Mark Allen Weiss (2002), Pearson Education

Other useful resource(s):

1. Link to NPTEL course contents: https://nptel.ac.in/courses/106102064/
2. Link to topics related to course:
   a. https://onlinecourses.nptel.ac.in/noc18_cs25/preview
   b. https://nptel.ac.in/courses/106103069/

c. http://www.nptelvideos.in/2012/11/data-structures-and-algorithms.html

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course Outcomes (Data Structure and Algorithms)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	3	2	2	3	2	2	2	3	1	3	**2.4**
CO-2	3	3	3	2	3	2	3	2	2	3	1	3	**2.5**
CO-3	3	3	3	2	2	3	1	2	3	3	1	3	**2.4**
CO-4	3	3	3	2	3	3	2	2	3	3	1	3	**2.6**
CO-5	3	3	3	2	3	3	2	2	3	3	1	3	**2.6**
CO-6	3	3	3	2	3	3	2	2	2	3	1	3	**2.5**
Average	**3**	**3**	**3**	**2**	**2.7**	**2.8**	**2**	**2**	**2.5**	**3**	**1**	**3**	

Data Structure and Algorithms Lab

COURSE CODE: 18B17CI271

COURSE CREDITS: 2

CORE/ELECTIVE: CORE

: 0-0-4

Pre-requisites: None

Course Objectives:

1. Develop problem solving ability using Programming
2. Develop ability to design and analyze algorithms
3. Introduce students to data abstraction and fundamental data structures
4. Develop ability to design and evaluate Abstract Data Types and data structures
5. Apply data structure concepts to various examples and real life applications

Course outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	To gain knowledge on the notions of data structure, Abstract Data Type	Familiarity
CO-2	To have hands on skills to evaluate different kinds of linked lists and their applications in day to day problem solving.	Usage
CO-3	To have hands on skills to evaluate different kinds stacks and their applications and implementations in day to day problem solving	Assessment
CO-4	To have hands on skills to evaluate different kinds queues and their applications and implementations in simulations.	Assessment
CO-5	To acquire knowledge of various sorting algorithms	Usage
CO-6	To learn Searching: Balanced tree, red-black tree, lower bounds for searching	Usage
CO-7	To learn to code for operations on Tree or BST (Creation; Traversing like pre-order,post-order and in-order; Searching element; finding height etc.)	Usage
CO-8	Introduction to Heaps	Usage
CO-9	To learn to code for operations on Graphs (Creation; entering info, printing output and deleting; traversal of BFS and DFS algorithm)	Assessment

List of Experiments:

S.No	Description	Hours
1	**Getting acquainted with** a) Arrays and Strings, Structures, b) Recursion, Pointers c) Dynamic memory allocation	 2 4 4
2	**Operations on: (Creation, insertion, deletion, sorting, traversing, reversing etc)** a) Linear Linked List, b) Doubly and c) Circular Linked List	 4 4 2

3	**Operations on Stacks:** a) Creation; pushing; popping; b) testing underflow, overflow; c) prefix and postfix	 4 2 2
4	**Operations on Queues:** a) Creation; b) enqueue; dequeue; c) testing underflow, overflow	 4 2 2
5	**Operations on Tree or BST:** Creation; a) Traversing like preorder, post-order and in-order; b) Searching element; finding height etc.	 4 2
6	**Implementation of sorting algorithms 1:** Insertion Sort and Selection Sort Algorithm with arrays using dynamic memory allocation.	2
7	**Implementation of sorting algorithms 2:** Bubble Sort and Merge Sort Algorithm with arrays using dynamic memory allocation.	2
8	**Implementation of sorting algorithms 3:** Implementation of Radix Sort and Quick Sort Algorithm with arrays using dynamic memory allocation.	2
9	**Operation on Heaps:** a) Heaps, b) Heap Sort	 2 2
10	**Implementation of Searching algorithms:** Linear Search Algorithm and Binary Search Algorithm using dynamic memory allocation.	2
11	**Operations on Graphs :** (Creation; entering info; printing Output and deleting; traversal of BFS and DFS algorithm etc.)	2
Total Lab hours		**56**

Minor Project(s) – (*Only for 2 credit lab)*

- Design GUI based program to solve any binary equation.
- Design GUI based program to find the roots of quadratic equation.

- Design a program that picks the characters at equal interval from the given text/paragraph and generate a new paragraph in which each set of word can't have more than 4 characters. Last word of the paragraph can have <=4 characters.
- Program to input following data into disk file. Code, name, department and salary of employee in a firm. After creating file read the file and find following-
  Methodology
  algorithms
  Code execution
  Future scope
  Count number of employees as per department
  Search record of employee
  Display record of employee
  Display list of employee in alphabetical order as per department
  Read record from file

Suggested Books/Resources:

1. Langsam, Augestein, Tenenbaum : Data Structures using C and C++, 2nd Edn, 2000, Horowitz and Sahani : Fundamental of Data Structures in C, 2nd Edn, 2008
2. Weiss : Data Structures and Algorithm Analysis in C/C++, 3rd Edn, 2006
3. Sahani : Data Structures, Algorithms and applications in C++, 1997.
4. Corman et al : Introduction to Algorithms, 3rd Edn., 2009
5. http://www.nptel.iitm.ac.in/video.php?subjectId=106102064, last accessed Mar 13, 2014.
6. http://www.cs.auckland.ac.nz/~jmor159/PLDS210/ds_ToC.html, last accessed Mar 13, 2014.
7. http://courses.cs.vt.edu/csonline/DataStructures/Lessons/index.html, last accessed Mar 13, 2014.
8. Link to topics related to course:
    a. http://cse.iitkgp.ac.in/~pallab/pds16/pds16.htm
    b. https://onlinecourses.nptel.ac.in/programming101/preview

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Attendance	15 Marks
4	Lab Assessment	45 Marks
	Total	100 marks

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Average
CO-1	3	2	3	2	2	3	3	3	2	3	2	2	**2.5**
CO-2	3	3	3	2	3	3	3	3	2	3	2	3	**2.8**
CO-3	3	3	3	2	2	3	3	3	3	3	2	2	**2.7**
CO-4	3	3	3	3	3	3	3	2	2	3	3	3	**2.8**
CO-5	3	3	3	2	2	2	3	3	3	3	2	2	**2.6**
CO-6	3	3	3	3	3	3	3	2	2	3	3	3	**2.8**
CO-7	3	3	3	3	3	3	2	2	3	3	3	3	**2.8**
CO-8	3	3	3	2	3	3	3	3	3	3	2	3	**2.8**
CO-9	3	3	2	3	3	3	3	3	3	2	3	3	**2.8**
Average	**3**	**2.9**	**2.9**	**2.4**	**2.7**	**2.9**	**2.9**	**2.7**	**2.6**	**2.9**	**2.4**	**2.7**	

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Data Simulation Lab

COURSE CODE: 18B17CI473

COURSE CREDITS: 2

CORE/ELECTIVE: CORE

L-T-P: 0-0-4

Pre-requisite: None

Course Objectives:

1. Student will learn simulation of real world problems using python, numpy, scipy and simpy.
2. Students will learn structural development of complex system in terms of process, resources and lavels
3. Student will learn to use random number generator.
4. Students will learn to monitor and tally simulation results.
5. Students will apply simulation and modeling techniques in many real examples and develop projects.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Student will learn simulation of real world problems using python, scipy and simpy.	Familiarity
CO-2	Students will learn structural development of complex system in terms of process, resources and levels	Assessment
CO-3	Student will learn to use random number generator.	Assessment
CO-4	Students will learn to monitor and tally simulation re0sults.	Assessment
CO-5	Students will apply simulation and modelling techniques in many real examples.	Usage
CO-6	Students will apply simulation and modelling techniques in a real life project.	Usage

List of Experiments

S.No	Description	Hours
1	Simpy Getting started	**2**
2	Simple simulation	**2**
3	Simulation with tracing	**2**
4	Executing simulations event-by-event	**2**
5	Synchronizing simulation time with wallclock time	**2**
6	Event stepping of models with a GUI	**2**
7	Debugging	**2**
8	GUI for SimPy simulations	**2**
9	Plot for simulation	**2**
10	Statistical parameters	**2**
11	Random number	**2**
12	Inference and Output monitoring	**2**
13	MID SEM TEST	**2**
14	DES simulation on simpy	**2**
15	Simpy more features	**2**
16	Simpy internals	**2**
17	Example: MACHINE BREAKDOWN	**2**
18	Example: CAR WASH	**2**
19	Example: CELL PHONE NETWORK	**2**
20	Example: Resource pool	**2**

21	Group Project	**2**
22	Group Project	**2**
23	Group Project	**2**
24	Group Project	**2**
25	Group Project	**2**
26	Group Project	**2**
27	Group Project	**2**
28	End Semester Test	**2**
Total Lab hours		**56**

Suggested Books/Resources:

i. T. H Cormen, C E Leiserson, R L Rivest and C Stein: Introduction to Algorithms, 3rd Edition, Prentice-Hall of India, 2010.
ii. Kenneth A. Berman, Jerome L. Paul: Algorithms, Cengage Learning, 2002.
iii. Ellis Horowitz, Sartaj Sahni, S.Rajasekharan: Fundamentals of Computer Algorithms, 2nd Edition, Universities press, 2007
iv. https://nptel.ac.in/courses/106104019/26
v. https://nptel.ac.in/courses/106104019/2Ev

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Attendance	15 Marks
4	Lab Assessment	45 Marks
	Total	100 marks

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	Average
CO1	3	3	3	1	2	1	3	3	2	3	3	3	**2.5**
CO2	3	3	3	3	2	2	3	3	2	3	3	3	**2.8**
CO3	3	3	3	3	2	2	3	3	2	3	3	3	**2.8**
CO4	3	3	3	3	2	2	3	3	2	3	3	3	**2.8**
CO5	3	3	3	3	2	2	3	3	2	3	3	3	**2.8**
C06	3	3	3	1	2	3	3	3	3	3	3	3	**2.8**
Average	**3**	**3**	**3**	**2.3**	**2**	**2**	**3**	**3**	**2.2**	**3**	**3**	**3**	

Operating Systems Lab

COURSE CODE: 18B17CI471

COURSE CREDITS: 2

CORE/ELECTIVE: CORE

L-T-P: 0-0-4

Pre-requisite: None

Course Objectives:

1. Be able to create sockets and analyze different (client/server) models.
2. Be able to create processes, threads, semaphores.
3. Be able to analyze different protocols.
4. Be able to learn how resources are being managed in Operating system.
5. Be able to manage system memory.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO1	Understand basics of MATLAB syntax, functions and programming.	Familiarity
CO2	Generate and characterize various continuous and discrete time signals.	Familiarity
CO3	Perform the basic operations on the signals.	Computational skills
CO4	Design and analyze linear time-invariant (LTI) systems and compute its response.	Technical skills
CO5	Analyze the spectral characteristics of signals using Fourier analysis.	Technical skills
CO6	Analyze the systems using Laplace transform and Z-transform.	Technical skills

List of Experiments

S.No	Description	Hours
1	Process Handling	**2**
2	Zombie and Orphan Process	**2**
3	FCFS Scheduling Algorithm	**2**
4	SJF Scheduling Algorithm	**2**
5	Priority Scheduling Algorithm	**2**
6	Round-Robin Scheduling Algorithm	**2**
7	Process Groups	**2**
8	Inter-Process Communication	**2**
9	Shared Memory Concept	**2**
10	Peterson‟s Critical Section Problem Solution	**2**
11	Mutex	**2**
12	Semaphores	**2**
13	MID SEM TEST	**2**

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14	Safety Algorithm	**2**
15	Banker‟s Algorithm	**2**
16	Page Replacement algorithm: FIFO	**2**
17	Page Replacement algorithm: LRU	**2**
18	Page Replacement algorithm: Optimal Replacement	**2**
19	Disk Scheduling : C-SCAN	**2**
20	Disk Scheduling : C-LOOK	**2**
21	Group Project	**2**
22	Group Project	**2**
23	Group Project	**2**
24	Group Project	**2**
25	Group Project	**2**
26	Group Project	**2**
27	Group Project	**2**
28	END SEM TEST	**2**
Total Lab hours		**56**

Suggested Books/Resources:

1. Silberschatz and Galvin, Operating System Concepts.
2. Tanenbaum ,S.A Woodhull, Operating System :Design and Implementation
3. W. Stallings, Operating System:Internals and Design Principles

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Attendance	15 Marks
4	Lab Assessment	45 Marks
	Total	100 marks

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Average
CO1	3	3	3	2	2	3	2	2	2	3	1	3	**2.4**
CO2	3	3	3	2	3	2	3	2	2	3	1	3	**2.5**
CO3	3	3	3	2	2	3	1	2	3	3	1	3	**2.4**
CO4	3	3	3	2	3	3	2	2	3	3	1	3	**2.6**
CO5	3	3	3	2	3	3	2	2	3	3	1	3	**2.6**
CO6	3	3	3	2	3	3	2	2	2	3	1	3	**2.5**
Average	**3**	**3**	**3**	**2**	**2.7**	**2.8**	**2**	**2**	**2.5**	**3**	**1**	**3**	

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Electronic Devices and Circuits Lab

COURSE CODE: 18B17EC373

COURSE CREDITS: 1

CORE/ELECTIVE: CORE

: 0-0-2

Pre-requisite: None

Course Objectives:

1. To analyze the characteristics and applications of Diode, BJT, and FET.
2. To design the amplifiers using BJT & FET and analyze their frequency responses

Course Outcomes:

Upon successful completion of this course the students will be able to:

S. No.	Course Outcomes	Level of Attainment
CO-1	Understand the V-I characteristics of diodes and its application as a switch and in wave shaping circuits.	Familiarity
CO-2	Design of voltage regulator circuits using zener diode and half wave / full wave rectifiers using PN junction diodes.	Familiarity
CO-3	Understand the V-I characteristics of BJTs and its use in design of voltage and current amplifiers	Usage
CO-4	Understand the Drain and transfer characteristics of FETs and its use in design of logic gates	Usage
CO-5	Design of single stage RC coupled amplifiers using BJTs and verifying the AC equivalent model for them.	Assessment
CO-6	Study the frequency response of BJTs and FETs	Assessment

List of Experiments

S. No	Description	Hours
1	To plot the characteristics of a diode in forward and reverse biased conditions.	2
2	i) To plot the Zener diode characteristics and find the Zener voltage. ii) To plot its transfer characteristics for a given load.	2
3	To implement a Half-Wave Rectifier circuit with and without a capacitive filter and to calculate its ripple factor.	2
4	To implement a full-Wave Rectifier circuit with and without a capacitive filter and to calculate its ripple factor.	2
5	To implement diode clipper and clampers circuits and observe the output waveforms on the CRO.	2
6	To plot input and output characteristics of a transistor in Common- Emitter configuration.	2
7	To compare the performance of fixed bias, emitter stabilized bias and voltage divider bias circuit.	2
8	To investigate the effect of R2 and RE on the stability of operating point for voltage divider bias circuit.	2
9	To design single stage CE amplifier using BJT and calculate the h- parameter model.	2
10	To plot the drain and transfer characteristics of a JFET in common- source configuration.	2
11	To design a two stage RC coupled amplifier and observe frequency response	2

12	To design a RC coupled amplifier and observe frequency response	2
Total Lab hours		24

Suggested Resources:

1. Robert L. Boylestad and Lois Nashelsky "Electronic Devices and Circuit Theory", 9th Edition, PHI, 2007.
2. Sedra Smith, "Microelectronic Circuits", 5th Edition, Oxford , 2012.
3. Bell "Electronic Devices and Circuit ", 5th Edition, Oxford, 2011
4. Link to NPTEL course contents: https://nptel.ac.in/courses/117103063/
5. Link to topics related to course: https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-012-microelectronic- devices-and-circuits-spring-2009/

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Attendance	15 Marks
4	Lab Assessment	45 Marks
	Total	100 marks

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Average
CO1	3	3	3	3	2	2	1	1	1	1	1	1	1.8
CO2	3	3	3	3	3	1	1	1	1	1	1	3	2
CO3	3	3	2	3	2	3	2	1	1	1	2	1	2
CO4	3	3	3	2	3	2	1	1	1	1	1	1	1.8
CO5	2	2	3	3	3	3	1	1	1	1	1	1	1.8
CO6	2	3	3	3	2	2	2	2	2	2	2	2	2.3
Average	2.7	2.8	2.8	2.8	2.5	2.2	1.3	1.17	1.17	1.17	1.3	1.5	

Engineering Graphics

COURSE CODE: 18B17GE173

COURSE CREDITS: 1.5

CORE/ELECTIVE: CORE

: 0-0-3

Pre-requisite: None

Course Objectives:

1. To introduce the students to the "universal language of Engineers" for effective communication through drafting exercises of geometrical solids.
2. To enable students to acquire and use engineering drawing skills as a means of accurately and clearly communicating ideas, information and instructions.
3. To impart knowledge to students about creating a sheet and software aided layout of required dimensions in 2-D and 3-D view.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO1	To impart and inculcate proper understanding of the theory of projection.	Familiarity
CO2	To improve the visualization skills	Assessment
CO3	To enable the students with various concepts like dimensioning, conventions and standards related to working drawings in order to become professionally efficient	Usage
CO4	To impart the knowledge on understanding and drawing of simple residential/office buildings.	Usage

List of Experiments

S.No	Description	Hours
1	Introduction to Lettering	**3**
2	Scales and their types	**2**
3	Construction of Polygons	**4**
4	Projection of points	**2**
5	Projection of lines	**4**
6	Projection of planes	**3**
7	Drawing of building plan	**6**
8	Introduction to Basic Commands in Auto-CAD	**3**
9	Orthographic projections in Auto-CAD	**3**
10	Isometric Projection in Auto-CAD	**4**
11	Projections of solids in Auto-CAD	**1**
12	Section of solids in Auto-CAD	**1**

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Total Lab hours	**36**

Suggested/Resources:

1. Engineering Drawing & Graphics with AutoCAD by K.Venugopal, New Age International Pvt. Ltd., New Delhi (India)
2. Engineering Drawing by N.D.Bhatt, V.M.Panchal and Pramod R. Ingle, Charotar Publishing House, Anand, Gujarat (India)
3. Engineering Drawing [With Introduction to Auto-CAD] by Roop Lal and Ramakant Rana, IK International Publishing House Pvt. Ltd.

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Attendance	10 Marks
4	Lab Assessment	50 Marks
	Total	**100 marks**

Department of Civil Engineering

Approved in Academic Council held on 25.10.2018

Engineering Mathematics I

COURSE CODE: 18B11MA111

COURSE CREDITS: 4

CORE/ELECTIVE: CORE

L-T-P: 3-1-0

Pre-requisite: Basic concepts of calculus and algebra

Course Objectives:

1. Various techniques of Multivariate Calculus and Integral Calculus.
2. The fundamental concepts of Vector Calculus.
3. The fundamentals of Laplace transforms and their applications.
4. To develop the essential tool of Matrices and Linear Algebra in a comprehensive manner.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Evaluate partial derivatives with its physical significance and expand functions of several variables.	Familiarity & Usage
CO-2	Find maxima and minima of functions of several variables with / without constraints.	Assessment
CO-3	Find areas and volumes of solids using multiple integration	Assessment
CO-4	Understand the calculus of vectors and vector valued functions with their physical significance	Familiarity & Usage
CO-5	Use Laplace transforms and inverse Laplace transforms to solve IVP	Usage
CO-6	Solve linear systems of equations and perform diagonalization of matrices	Usage

Course Contents:

Unit	Contents	Lectures required
1	**Differential Calculus:** Limits and continuity of function, Partial Differentiation, Chain rule, Total Derivative; Maxima, Minima and Saddle points; Method of Lagrange's multipliers, Taylor's series for two or more variables	10
2	**Integral Calculus:** Improper integrals; Beta and Gamma functions and their properties; Double integrals, Change of order and Change of variables, Applications to areas and volumes.	10
3	**Vector Calculus:** Equations to a line and a plane, Tangent plane and Normal line, Gradient, Curl and divergence and their physical significance, Directional derivatives, Line and surface integrals.	6
4	**Laplace Transform:** Laplace Transform, Inverse Laplace transform, Convolution, Dirac delta and Unit Step function, Solution of initial value problems.	6
5	**Matrices:** Algebra of matrices, Row Echelon form, Inverse and Rank of a matrix, Symmetric, Skew- symmetric and Orthogonal matrices; Determinants; Solution of systems of linear equations (Gauss's elimination, Rank method), Linear Independence and Dependence of vectors. Eigen values and Eigenvectors; Cayley-Hamilton Theorem, Diagonalization of matrices and Orthogonal transformation.	10
Total lectures		**42**

Suggested Text Book(s):

1. G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, 9th Edition, Pearson, 2002.
2. Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
3. Jain and Iyengar, Advanced Engineering Mathematics, Narosa Publishing House.

Suggested Reference Book(s):

1. Ramana B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 11thReprint, 2010.
2. D. Poole, Linear Algebra: A Modern Introduction, 2nd Edition, Brooks/Cole, 2005.
3. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 36th Edition, 2010.

Other useful resource(s):

1. Link to NPTEL course contents: https://onlinecourses.nptel.ac.in/noc18_ma05/preview
2. Link to topics related to course:
   i. https://www.whitman.edu/mathematics/calculus_online/chapter14.html
   ii. https://nptel.ac.in/courses/103103037/5
   iii. https://nptel.ac.in/courses/111106051
   iv. https://nptel.ac.in/courses/111107108/25
   v. https://nptel.ac.in/courses/117101056/16

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1.	T-1	15	1 Hour.	Syllabus covered upto T-1
2.	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (1) - 5 Quizzes (2) - 15 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Engineering Mathematics I)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	1	0	1	2	1	0	0	0	2	1	1	1
CO-2	3	2	3	1	2	1	0	0	0	1	2	2	1.5
CO-3	2	1	1	0	1	1	0	0	0	2	1	2	1
CO-4	3	1	1	1	2	2	0	0	0	2	1	2	1.5
CO-5	2	2	1	2	1	2	0	0	0	1	2	3	1.5
CO-6	3	2	1	1	1	2	0	0	0	2	2	3	1.5
Average	2.67	1.5	1.17	1	1.5	1.5	0	0	0	1.67	1.5	2.17	

Engineering Mathematics II

COURSE CODE: 18B11MA211

COURSE CREDITS: 4

CORE/ELECTIVE: CORE

: 3-1-0

Pre-requisite: Engineering Mathematics I

Course Objectives:

1. The various methods of solving the second order differential equations with variable coefficients, to study the basic properties of Bessel Functions, Legendre polynomials, Chebyshev polynomials and their Applications.
2. To obtain solutions of Wave, Diffusion and Laplace Equation.
3. To study calculus of complex variables.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Solve problems related to convergence of series	Familiarity & Usage
CO-2	Understand basics of Ordinary Differential equation	Assessment
CO-3	Comprehend series solution with certain special functions e.g. Bessel, Legendre Eqn.	Usage
CO-4	understand partial differential Eqn and Solve Heat, wave & Laplace equation	Usage
CO-5	Understand Functions of a complex variable, Analytic functions, Mobius Transformation	Usage
CO-6	Solve Contour integration and find Taylor's and Laurent's series	Familiarity & Usage
CO-7	Evaluate certain real defnite and improper integrals.	Usage

Course Contents:

Unit	Contents	Lectures required
1	**Sequences and Series:** Convergence of sequence and series, tests for convergence; Power series, Fourier series: Half range sine and cosine series, Parseval's theorem.	7
2	**Differential Equations Part I:** Basics of first order Differential Equations, Second and Higher order differential equations with constant coefficients. Second order linear differential equations with variable coefficients, method of variation of parameters, Cauchy-Euler equation;	7
3	**Differential Equations Part II:** Power series solutions; Legendre polynomials, Bessel functions of the first kind and their properties. Introduction to Partial Differential Equations, Solutions of One dimensional Wave, Heat Equation & Laplace Equation.	12
4	**Complex Variable – Differentiation:** Differentiation, Cauchy-Riemann equations, analytic functions, harmonic functions, finding harmonic conjugate; elementary analytic functions (exponential, trigonometric, logarithm) and their properties; Conformal mappings, Mobius transformations and their properties.	8

5	**Complex Variable – Integration:** Contour integrals, Cauchy Theorem, Cauchy Integral formula, Liouville's theorem and Maximum-Modulus theorem; Taylor's series, zeros of analytic functions, singularities, Laurent's series; **[CO-6]** Residues, Cauchy Residue theorem, Evaluation of definite integral involving sine and cosine, improper integrals.	**8**
Total lectures		**42**

Suggested Text Book(s):

1. Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006
2. Jain and Iyengar, Advanced Engineering Mathematics, Narosa Publishing House

Suggested Reference Book(s):

1. Simmons, G.F., Differential Equations with Applications, 2nd Ed, McGraw-Hill, 1991.
2. Brown, J.W., Churchill, R.V. , Complex Variables and Applications, 6th Ed., McGrawHill, 1996.
3. Spiegel, Murray R, Theory and Problems of Complex variables Schaum's series.
4. Sneddon I. N., Introduction to Partial Differential Equations, Dover Publications, 2006

Other useful resource(s):

1. Link to NPTEL course contents: https://nptel.ac.in/courses/122101003/2
2. Link to topics related to course:
   i. https://nptel.ac.in/courses/111104031/
   ii. https://nptel.ac.in/courses/111104031/8
   iii. https://nptel.ac.in/courses/122107037/29
   iv. https://nptel.ac.in/courses/111107056/
   v. https://nptel.ac.in/courses/117101055/14

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1.	T-1	15	1 Hour.	Syllabus covered upto T-1
2.	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (1) - 5 Quizzes (2) - 15 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Engineering Mathematics II)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	1	0	1	2	1	0	0	0	2	1	1	1
CO-2	2	2	1	1	1	2	0	0	0	1	2	2	1.5

CO-3	3	2	1	0	2	1	0	0	0	1	1	3	1.5
CO-4	3	1	2	1	2	2	0	0	0	2	1	2	1.5
CO-5	2	2	1	2	1	1	0	0	0	2	2	2	1.5
CO-6	3	2	2	1	2	1	0	0	0	1	2	1	1.5
CO-7	3	1	1	0	2	2	0	0	0	2	1	2	1.5
Average	2.71	1.57	1.14	1	1.71	1.42	0	0	0	1.57	1.42	1.85	

Embedded Systems

COURSE CODE: 19B1WEC632

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

To learn about the embedded system application areas, design challenges, design and development methodology, tools used for embedded system design, embedded system integration and testing.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Understand various components of embedded system, design challenges and design metrics	Familiarity
CO-2	Learn about embedded system programming through 8051 microcontroller, programming and I/O interfacing	Usage
CO-3	Comprehend RISC architecture, programming of ARM and PIC microcontrollers	Usage
CO-4	Know about embedded system design and development methodology, tools and languages used for embedded system design	Usage
CO-5	Learn about integration and testing of embedded systems	Assessment

Course Contents:

Unit	Contents	Lectures required
1.	Introduction: Embedded systems overview, Classification, Application areas, Design challenges – real-time execution, physical size, power consumption, multirate operation. Design metrics – time-to-market, unit cost, performance.	4
2.	Typical Embedded System: Core of the embedded system, Sensors and actuators, Communication interface, Embedded firmware	6
3.	8051 Microcontroller: 8051 Architecture, timers and interrupts, Special function registers, Program/ data memory, addressing modes. instruction set, interrupts,	8
4.	ARM Processor Fundamentals and Architectures, ARM Instruction Set, PIC Microcontroller and its Architecture.	10
5.	Design and Development of Embedded product: Analog Electronic Components, Digital Electronic Components, Electronic design automation tools, Embedded firmware design approaches, Embedded firmware development languages	8
6.	Integration and testing of embedded hardware and firmware, Embedded system development environment, Product enclosure design and development, Embedded product development life cycle, Trends in embedded industry	6
Total		42

Suggested Text Book(s):

1. Frank Vahid and Tony Givargis, "Embedded system design: A unified Hardware/Software introduction,"3rd Ed., Wiley 2014
2. Shibu K. V, "Introduction to Embedded Systems," 2nd Ed., McGraw Hill 2017

Suggested Reference Book(s):

1. Steve Furber, "ARM System-on-Chip Architecture," 2nd Ed., Pearson 2012
2. Tim Wilmshurst, "Designing Embedded Systems with PIC Microcontrollers: Principles and Applications," 2nd Ed., Newnes 2009
3. Steven F Barrett and Daniel J Pack, "Embedded Systems Design and Applications with the 68HC12 and HCS12," 1st Ed., Pearson 2012
4. Kenneth Ayala, "The 8051 microcontroller," 3rd Ed., Thomson, 2005

Other useful resource(s):

NPTEL ONLINE COURSES

1. Embedded Systems: https://nptel.ac.in/courses/108105057/ (Prof. A. Routray, Prof. Rajib Mall, Prof. Amit Patra, IIT Kharagpur)
2. Embedded Systems: https://nptel.ac.in/courses/108102045/ (Prof. Santanu Chaudhary, IIT Delhi)
3. Embedded Systems Design: https://nptel.ac.in/courses/106105159/ (Prof. Anupam Basu ,IIT Kharagpur)

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Average
CO1	2	1	2	1	2	1	1	1	1	1	3	1	1.4
CO2	3	3	3	2	3	2	1	1	2	3	1	3	2.3
CO3	3	2	3	2	3	2	1	1	1	2	1	2	1.9
CO4	3	2	3	2	3	2	1	1	1	1	1	2	1.8
CO5	3	2	3	2	3	2	1	1	1	1	1	2	1.8
CO6	3	2	3	2	2	3	1	1	2	2	1	1	1.9
Average	2.8	2.0	2.8	1.8	2.7	2.0	1.0	1.0	1.3	1.7	1.3	1.8	

English and Communication: Lab

Course Goal

'English and Communication: Lab' aims at developing the verbal/written skills of the students with emphasis on learning grammatical concepts and syntactical strategies. The lab based softwares (Tense Buster and Business Writing) particularly focus on sharpening language skills of the students and grooming their personality. This would include expressing thoughts in the written form logically, precisely and appropriately; understanding the essentials of successful job applications with command over language and using economy of words; help in making communication stronger, facilitating working faster and better.

Course Objectives

1. The students will learn to speak and write grammatically correct sentences with the ability to express thoughts with clarity and accuracy.

2. The students will learn the rules of grammar in writing. It will enhance their ability to use logical sequencing while writing any business letter or document.

3. The students will learn using new words and build their vocabulary steadily and systematically by following the exercises.

4. Students will develop command over their language and synchronize their thoughts while writing different types and kinds of Business letters.

5. Students will be groomed to develop the art of speaking logically, confidently and pragmatically, involving understanding work ethics, manners and correct use of body language.

Detailed Syllabi
Lecture-wise Breakup

Subject Code		**Semester**	1
Subject Name	English and Communication: Lab		
Credits	02	**Contact Hours**	14

Faculty (Names)	Coordinator(s)	1. Dr. Papiya Lahiri
	Teacher(s) (Alphabetically)	

Lab Exercise No.	Subtitle of the Module	Topics	No. of Lab Exercises
	The Writing Process	Key vocabulary for writing How do you write Vocabulary: What is a document The Writing process Prepositions The Writing process: some thoughts	1
	Linking Ideas (I)	Linking by time Linking by contrast and logic Test yourself (learn about sequencing, exemplifying, highlighting and logic)	1
	Linking Ideas (I)	Referencing Words (1) Practice linking ideas (using connectors) Grammatical focus (Agreement)	1
	Applying for a Job	Online Application (Spell Check) Use action words Resumes- the basics	1

		Look at a Resume Applying for a Job: a thought The Covering letter	
	Business Letters	Grammar focus: contractions A letter of complaint A letter of apology Words: formal or informal? (Writing clearly and appropriately)	1
	Writing letters	Successful emails: the basics (Alternatives to gender- specific words) Marketing emails: some thoughts Perfecting your document (Spell checking) Emails and letters: case studies (Analyze a formal response) Emails and Letters (Grammar Focus: Modals)	1
	Use of Body Language	This exercise will include showing a couple of videos to the students on the use of Body Language in communication and also how to interpret other people's body language when they communicate. This will include studying facial expressions, gestures, non- verbal cues and eye contact.	1

	Use of Power point presentation	This exercise will comprise of two videos on the specifics of preparing power- point presentations; the Do's and don'ts; examples from successful business entrepreneurs' presentations.	1
	Vocabulary Development	Synonyms, Antonyms, Standard Abbreviations One word Substitution Homophones, Homonyms, Paronyms, Words often confused and misused Word Functioning Idiomatically Foreign Words Prefixes Suffixes	2
	Reports: **Organizing Information**	What will I learn? Organizing information Why is organization important? Finding information Other Report types (Only reading) Write a report Grammar focus: past or present? (1) Grammar Focus: past or present? (2)	1
	Reported Speech	Introduction The Rule Practice: Pronouns	1

		Practice: Verbal Actions Pronunciation: Stress and Rhythm Do you understand Vocab: reporting verb Your test	
	Perfecting your Document (I)	What will I learn? The elements of formatting Format a document British or North American?	1
	Perfecting your Document (II)	Proofreading: Grammar mistakes Practice Proofreading Spell Checking Common Misspellings Final thought: the golden rules	1
		Total	14

Methodology

The course will follow a lab based teaching-learning method with classroom discussions and activities on fundamental concepts of grammar with a strong emphasis on skill development of students with regard to speaking, writing, logically interpreting ideas into words and reasoning in the classroom. Both lab and tutorial activities are run on student –teacher individual and group interactions.

Evaluation

Sr. No.	Components	Total Marks
1	**File**	15
2	**Attendance**	15
3	**Class Exercises**	30
4	Mid Term	20
5	End term	20
	Total	100

There are presently three softwares running in the Language Lab. These are as follows:

1. **Software Clarity S. Net 7**

This software supports Wireless LAN and wired LAN.

Main Functions

1. Screen Broadcast: Teacher PC can broadcast the screen, video file, flash smoothly without delay to student PC.

2. Voice Broadcast: Teacher can broadcast his voice without delay to student PC.

3. Screen Recorder: Teacher and student can record their own operations and then save in video file, which can be broadcast in any PC which has installed media player

4. Monitor: Teacher can monitor any student PC in the classroom.

5. Media Player. Teacher can broadcast all kinds media file formats, such as MPEG, DAT, MVI and so on, to student PC without delay.

6. Control Website and application: Teacher can restrict student to visit any website or application freely.

7. Teacher can remote open website on student PC.

8. Group Teaching: Teacher can divide the students into several groups, and set leader for each group to run group teaching.

9. Exam: It has strong exam functions. Teacher can know student study progress from students by using this function easily.

10. Remote Command: Teacher can remote run the program in student PC; teacher can remote start-up, turn off and restart student computer.

11. File transfer and collect the file: Teacher can transfer the file to student PC easily, and also teacher can collect the file from student PC.

12. Restrict USB: Teacher can restrict student to use USB flash memory freely. 13. Digital Recorder: It can record teacher and student voice, which can be used in language lab.

Requirements

Teacher side Requirements: CPU Core 2 E6300, 2Gbytes Memory, 256Mbytes Display Card

Student side Requirements: CPU Core 2 E4300, 1Gbytes Memory, 128Mbytes Display Card

Operating System: Support all Windows, includes Windows 8.1,8, 7, Vista, XP and so on. Network: Wired Network 10MB/100MB/1000MB. Wireless Network 802.11n.

2. Software: Tense Buster 9.0

Tense Buster is an ESL (English as a second language) program which focuses on helping students improve their reading, writing, listening, speaking, vocabulary and grammar skills in 5 levels (beginner, upper intermediate, intermediate, lower intermediate, advanced).

Tense Buster covers 33 aspects of the English language through presentations, practice exercises, rules, tests and learner training tips. Students learn how to ask questions, make comparisons, and report on what they've heard, in addition to learning how to describe past, present and future events.

Each unit begins with a presentation of a grammar topic based on a dialogue, a newspaper article, a radio broadcast or an extract from a story, where learners are encouraged to form theories about how the grammar works. Next comes checking questions focusing on key areas of difficulty, and a grammar rule. Students move on to practice and testing activities in which the language is contextualized and key aspects of form and function are highlighted. Each unit includes a video-based pronunciation activity relating to an aspect of the grammar. Finally, each unit includes a vocabulary session and ends by suggesting extension activities. All activities include detailed feedback.

Multimedia Authoring Kit

This kit enables the teacher to create effective exercises tailored to students' specific needs. The Tense Buster multimedia Authoring Kit comprises a wide range of exercise types. It lets you add your own material and adapt the courses to the needs of your students. Use any one of these formats to create your own activities: drag and drop, proof reading and free practice as well as target spotting, multiple choice questions, true/false, text and gap fill.

3. **Software: Business Writing**

This software helps in developing the writing skills of the students. It has 8 core skill development areas:

The Writing Process

Applying for a Job

Successful letters: the basics

Successful emails: the basics

Emails and Letters: Case Studies

Writing clearly and appropriately

Linking Ideas

Reports: Organizing information

Key sections of a Report

Perfecting your document

Each area deals with around 10 topics about the background, grammar and objective type questions on the selected topic. The Lab exercises will be covered from Tense Buster and Business Writing software.

Evaluation

Sr. No.	Components	Total Marks
1	**Test 1**	15
2	**Test 2**	25
3	**Test 3**	35
4	**Internal Assessment**	25

Environmental Chemistry and Microbiology

COURSE CODE – 18M11CE111

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE
L-T-P: 3-0-0

Pre-requisite: Basics of chemistry

Course Objectives:

1. To familiarize the students with the chemical aspects and principles as applied to environmental engineering.
2. To develop the understanding about the biological principles as linked with the environmental engineering.
3. To be able to apply the physical, chemical and biological parameters of the treatment and pollution control.
4. To lay out the ground work for understanding water and waste water analysis on fundamental basis of environmental engineering practice and research.
5. To analyze and interpret the environmental engineering systems from chemistry and microbiological point of view.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Understand the basic concepts of environmental chemistry, chemical equilibrium, reaction kinetics and acids and base in dealing with managing environmental problems.	Familiarity
CO-2	Understand the detailed concepts of microbiology features like bacteria, fungi, algae and various others forms of higher forms and their role in environment and its sustainability.	Familiarity
CO-3	Understand the importance of the microbial growth and enumeration, control of microorganisms and microbial diversity.	Assessment
CO-4	Comprehend the different components of metabolic pathways for remediating contaminated water, hazardous and solid waste and soil.	Usage
CO-5	Understand the impact of pollutants on environment, self-purification and disposal standards using various modelling methods.	Usage

Course Contents:

Unit	Contents	Lectures required
1	**Introduction**: Importance of chemistry and microbiology in environmental engineering, its related uses and applications.	**2**
2	**Chemical Reactions:** its types, solutions, activity, reactivity, coefficients, equilibrium involved and thermodynamics in relation to sustainable environment.	**4**
3	**Acid base equilibrium**: Equilibrium diagrams, carbonic acid system, buffering, Solubility Equilibrium, effect of other solutes on salt solubility, removal of heavy metals.	**8**

4	**Oxidation reduction equilibrium**: Electrochemistry and electrochemical cells, stability diagrams measuring redox potentials.	**6**
5	**Water stabilization**: Water softening and water conditioning, chemical precipitation, ion exchange.	**2**
6	**Basics of quantitative chemistry:** analytical methods, instrumentation: Organic pollution: BOD, COD, TOC.	**4**
7	**Microbiology**: Classification, identification, Taxonomy, Reproduction and growth, cultures & characteristics, Enzymes, Microbial metabolism - energy production, biosynthesis, Mixed and pure culture, Growth rate; Application.	**8**
8	**Microbiological Variants:** Fungi, Bacteria, molds and yeast, algae, protozoa, viruses. Control of microorganisms.	**4**
9	**Environmental Applications of Microbiology:** Microbiology of domestic water and wastewater, industrial microbiology. Epidemiology of infectious diseases, microbial agents of diseases.	**4**
Total lectures		**42**

Suggested Text Book(s):

1. J. S Birdie, G S Birdie: Water Supply and Sanitation Engineering, 9th Edition, Dhanpat Rai Publications, India, 2014.
2. Garg S.K: Environmental Engineering – Water Supply Engineering (Volume -1), Khanna Publishers, India, 2015.
3. B.C. Punmia, A.K. Jain, A.K. Jain: Water Supply Engineering, 2ndEdition, Laxmi Publications. India,2016.
4. Integrated Computer Applications in Water Supply: Applications and Implementations for Systems Operation and Management by Bryan Coulbeck (Volume 2), Annotation copyright Book News, Inc. Portland, Or.

Suggested Reference Book(s):

1. H. Peavy, D. Rowe, G.Tchobanoglous "Environmental Engineering", IstEdition, McGraw Higher Education Publications, India, 2017.
2. Chemistry for Environmental Engineering, Sawyer C.N., McCarty P.L., McGraw Hill Book Company, New York, 2002.
3. Microbiology – Concepts and applications, Pelczar M.J., McGraw Hill Book Company, New York,6th edition

Other useful resource(s):

1. Process Chemistry for water and wastewater treatment: Benefield L.D., Judkins J.F., Weand B.L., Prentice-Hall Inc, 1982.
2. Microbiology for Environmental Scientists and Engineers, Gaudy Jr. A.F. and Gaudy E.T., McGraw Hill Book Company, New York,1980
3. Standard Methods for the Examination of water and wastewater: APHA, WPCF,2005

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignments (10) - 10 Presentation(1) -10 Attendance/Quiz -5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course Outcomes (Environmental Chemistry and Microbiology)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	**2**
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	**2**
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	**1.75**
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	**2.0**
CO-5	2	2	3	3	3	2	2	1	3	2	2	2	**2.25**
Average	**2**	**2.4**	**2.6**	**2.6**	**2.6**	**1.4**	**1.6**	**1**	**2.2**	**2.2**	**1.6**	**2**	

Repair and Retrofitting of Structures

Sr. No.	Course Code	Course Title	Hrs/week			Credits
			L	T	P	
1.	CE	Design of Industrial Structures	3	0	0	3
2.	CE	Finite Element Methods	3	0	0	3
3.	CE	Bridge Engineering	3	0	0	3
4.	CE	Pre-stressed Concrete Design	3	0	0	3
5.	CE	Composite Materials and Structures	3	0	0	3
6.	CE	Plastic Analysis of Structures	3	0	0	3
7.	CE	Analysis and Design of Tall Buildings	3	0	0	3
8.	CE	Advanced Steel Design	3	0	0	3
9.	CE	Wind Resistant Design of Structures	3	0	0	3
10	CE	Stability of Structures	3	0	0	3
11	CE	Cable Stayed and Suspension Bridges	3	0	0	3
12	CE	Computer Application in Structural Analysis and Design	3	0	0	3
13	CE	Masonary Structures	3	0	0	3
14	CE	Recent Advances in Construction Materials	3	0	0	3
15	CE	Repair and Retrofitting of Structures	3	0	0	3
16	CE	Construction Methods and Equipments	3	0	0	3
17	CE	Design of Substructures	3	0	0	3
18	CE	Ground Improvement Engineering	3	0	0	3
19	CE	Soil Dynamics and Machine Foundations	3	0	0	3
20	CE	Soil Structure Interaction	3	0	0	3
21	CE	Water Resources System Planning	3	0	0	3
22	CE	Hydraulic Structures	3	0	0	3
23	CE	Geoenvironmental Engineering	3	0	0	3
24	CE	Solid and Hazardous Waste Management	3	0	0	3
25	CE	Advanced Environmental Engineering				
26	CE	Analysis and Design of Transportation Systems				
27	CE	Analysis and Design of Pavement Systems	3	0	0	3
28	CE	Quality and Safety Management in Construction	3	0	0	3
29	CE	Construction, Economics and Finance	3	0	0	3
30	CE	Research Methodology	3	0	0	3
31	CE	Nanotechnology and Concrete	3	0	0	3

Refer sl no 15 for COURSE CREDITS etc

Principles of retrofitting, objective and principles of intervention, design steps for intervention, criteria for repair and retrofitting, repair materials and techniques, seismic vulnerability evaluation of buildings, feasibility assessment, design considerations, analytical and experimental techniques, retrofit design and implementation, techniques of retrofitting and improving structural integrity of masonry buildings, codes of practices for repair and retrofitting, techniques of retrofitting of RC buildings and structural elements, retrofitting of bridges and dams and heritage structures, retrofitting of structures by seismic base isolation, case studies of retrofitting of structures.

18B1WCE738	Financial Management

Financial Management 3 3

Financial Management: Introduction, modern financing theory, real estate development & finance, construction accounting systems, analysis of financial statements, managing costs, determining labor burden, managing general overhead costs, setting profit margins for bidding, profit center analysis, cash flows for construction projects & construction companies, time value of money, risks & uncertainties and management decision in capital budgeting, taxation and inflation, financing a company's financial needs, tools for making financial decisions, interest factors, amortization schedule, computerized accounting systems, international financial management, practical problems & case studies.

Engineering Physics-I

COURSE CODE: 18B11PH111

COURSE CREDITS: 4

CORE/ELECTIVE: CORE

: 3-1-0

Pre-requisite: None

Course Objectives:

1. To enable the students to get better understanding about physical optics and its applications in engineering.
2. To familiarize students about modern physics and its applications in engineering.
3. To enable the students to get better understanding about thermal physics and its applications in engineering.
4. To familiarize students with relativistic mechanics.
5. At the conclusion of the course, the ability of students should have enhanced to think logically about the problems of science and technology and obtain their solutions

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	To learn the fundamental of physical optics	Familiarity
CO-2	To implement the concepts and theory for solving the application related problems of physical optics	Assessment
CO-3	To learn the basic and mathematical methods for relativity and related fields	Familiarity and Assessment
CO-4	To learn the basic concepts of modern , laser and thermal physics	Familiarity
CO-5	To implement the concept of modern and thermal physics ; analyzing and solving the related problems	Assessment and Implementation

Course Contents:

Unit	Contents	Lectures required
1	**Interference:** Introduction, Young's double slit experiment, Phase difference and Path Difference, Coherence, Analytical treatment of interference, Methods of interference (division of wave front & division of amplitude) Applications of interference in the field of engineering, Scientific applications of interference.	8
2	**Diffrection:** Introduction, Difference between interference and diffraction, Fresnel and Fraunhoffer class of diffraction, Diffraction grating, Applications of diffraction grating, Resolving and dispersive power of an optical instrument.	6
3	**Polarization:** Introduction, Difference between unpolarized and polarized light, Means of production of polarized light, Optical activity, specific rotation, Lorentz half shade and biquartz polarimeter.	4
4	**Atomic Physics:** Introduction, Quantum numbers, spin and orbital angular momentum, Atoms in magnetic field, Zeeman effect, Atoms in electric field,	4

	Stark effect.	
5	**Quantum Physics:** Wave particle duality, uncertainty principle and its applications, wave function, Schrodinger equation and its solutions, Particle in a box, Harmonic Oscillator	**6**
6	**Lasers:** Principle and working of laser, Different types of lasers (Three level and four level lasers).	**2**
7	**Thermal Physics:** Introduction, Zeroth law of Thermodynamics. First law of thermodynamics, Specific heat relation, Work done during an isothermal and adiabatic process. Second law of thermodynamics, concept of entropy, entropy for an ideal gas, Third law of thermodynamics, Principle of increase of entropy or degradation of energy, Reversible and irreversible processes. Carnot cycle and Carnot engine, Refrigerator, Clausius-Cleyperon equation, Thermodynamic Potentials, Maxwell's equations.	**8**
8	**Relativistic Mechanics**: Inertial & non-inertial frames, Michelson- Morley experiment, Einstein's postulates. Lorentz transformation, equations. Length contraction & Time dilation, Addition of velocities; Variation of mass with velocity Mass energy equivalence.	**4**
Total lectures		**42**

Suggested Text Book(s):

1. Engineering Physics, Shatendra Sharma & Jyotsna Sharma, Pearson Pub. 2018.
2. N. Subrahmanayam, Brij Lal and M.N. Avadhanulu, A Text Book of Optics, S. Chand (2012).
3. Brij Lal, N Subrahmanyam and P.S. Hemne, Heat Thermodynamics and Statistical Physics, S. Chand, 3rd edition 2012.
4. Arthur Beiser, Concepts of Modern Physics, McGraw Hill, 6th edition (1994).

Suggested Reference Book(s):

1. F.A. Jenkins and H.E. White, Fundamentals of Optics, McGraw-Hill (1981).
2. R. Eisberg and R. Resnick, Quantum Physics of Atoms, Molecules, Solids, Nuclei, and Particles, John Wiley & Sons, 2nd edition (1985).
3. Ajoy Ghatak, Optics, Tata McGraw Hill, 5th addition, (2012)

Other useful resource(s):

1. Link to topics related to course:

i. https://nptel.ac.in/courses/122107035/
ii. https://nptel.ac.in/courses/122103011/
iii. https://nptel.ac.in/courses/122101002/28
iv. https://nptel.ac.in/courses/122105023/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus

Approved in Academic Council held on 25.10.2021

4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Parallel and Distributed Algorithms)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2				2				2		2	**1.25**
CO-2	2	2	2	2	2	2				2		2	**2**
CO-3	3	2				2				2		2	**1.4**
CO-4	3	3				2				2		2	**1.5**
CO-5	3	3	3	3	3	3				3		3	**3**
Average	**2.6**	**2.4**	**2.5**	**2.5**	**2.5**	**2.2**				**2.2**		**2.2**	

Engineering Physics-II

COURSE CODE: 18B11PH211

COURSE CREDITS: 3

CORE/ELECTIVE: CORE

: 3-0-0

Pre-requisite: None

Course Objectives:

1. To offer a broad aspect of those areas of Physics which are specifically required as an essential background to engineering students for their studies in higher semesters.
2. To enable the students to get better understanding about solid state physics and its applications in engineering.
3. To familiarize students about electromagnetism and its applications in engineering.
4. To enable the students to get better understanding about statistical physics and its applications in engineering.
5. To familiarize students with optical fibers communication.
6. At the conclusion of the course, the ability of students should have enhanced to think logically about the problems of science and technology and obtain their solutions.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	To learn the fundamentals of vector calculus and its applications in electrostatics	Familiarity
CO-2	Knowledge of, physical interpretation, and ability to apply Maxwell's equations to determine field waves, potential waves, energy ,charge conservation conditions and other diverse engineering problems.	Familiarity/Assesment
CO-3	Able to distinguish Step Index, Graded index fibers and compute mode volume and Implementation of numerical methods for calculating the design parameters of optical fiber.	Familiarity/Problem Solving
CO-4	To understand the basics of statistical distributions and use Maxwell-Boltzmann distribution, Fermi-Dirac and Bose-Einstein distributions to solve problems in some physical systems	Familiarity/Problem Solving
CO-5	To analyze atomic structure, Crystal structure, Crystal axes and planes, X-ray diffraction data and effect of energy bands on electronic behavior of solids.	Analytical Skills/ Familiarity
CO-6	To understand the concepts of modern solid state physics ,various properties of semiconductors and apply Hall effect to calculate allied parameters of semiconductors	Familiarity/ Usage

Course Contents:

Unit	Contents	Lectures required
1	**Electromagnetism:** Basic knowledge of fields, gradient, divergence and curl, Coulomb's law and related numerical, electric flux, Gauss's law for the charge inside and outside the Gaussian surface, applications of Gauss law: spherical and cylindrical symmetries, electric field due to charged conductor, force per unit area on the surface of the charged conductor, treatment of electrostatic problems by solution of Laplace and Poisson's equations. Biot Savart law,	12

	Ampere's law, Maxwell's equations in free space and dielectric media, energy in electromagnetic waves (Poynting vector and Poynting theorem), plane electromagnetic waves in free space, transverse nature, wave impedance and energy flow, energy density and energy flux (Poynting vector) in an electromagnetic field, radiation pressure.	
2	**Statistical Physics & Applications:** Introduction, macrostates, microstates, thermodynamic probability, distribution of n-particles in k-cells, phase space, minimum volume, classical and quantum statistics: common approach to three statistics, Maxwell-Boltzmann (ideal gas), Bose-Einstein (photon gas), Fermi-Dirac distributions (electron gas), Compton effect.	**10**
3	**Optical Fiber Communication:** Light propagation in fibers, Step index and Graded Index fibers, Numerical Aperture and Attenuation, Single and Multimode fibers and their propagation characteristics, Fiber losses and optical fiber applications.	**4**
4	**Solid State Physics:** Basic ideas of bonding, ionic bonding, covalent bonding (hybridization), metallic bonding, dispersion bonds, dipole bonds, hydrogen bonds, Lattice points and space lattice, basis and crystal structure, unit cell and primitive cell, seven crystal systems and fourteen Bravais space lattice, coordination number, nearest neighbour distance, atomic radius, atomic packing factor in crystal structure, calculation of lattice constant, lattice planes and Miller indices, separation between lattice planes. X-ray diffraction, Bragg's law of X-ray diffraction, Bragg's x-ray spectrometer, powder crystal method, rotating crystal method. Electronic conduction in metals, classical free electron theory, quantum theory of free electrons, band theory of solids, distinction between metals, semiconductors and insulators, intrinsic and extrinsic semiconductors, carrier concentration in thermal equilibrium in intrinsic semiconductor, Fermi level and energy band diagram in intrinsic semiconductor, energy band diagram and Fermi level in extrinsic semiconductors, effect of temperature on extrinsic semiconductor, electrical conductivity of intrinsic semiconductor and extrinsic semiconductor, Hall effect, allied parameters and its applications.	**16**
Total lectures		**42**

Suggested Text Book(s):

1. David J Griffiths, Introduction to Electrodynamics, Eastern Economy Editions, PHI, 4th edition (2012).
2. Brij Lal, N Subrahmanyam and P.S. Hemne, Heat Thermodynamics and Statistical Physics, S. Chand, 3rd edition (2012).
3. Gerd Keiser, Optical Fiber Communication, Tata McGraw-Hill Education Pvt. Ltd., 5th edition (2013).
4. S. O. Pillai, Solid State Physics, New age international publishers, 7th edition (2016).

Suggested Reference Book(s):

1. Charles Kittel, Introduction to Solid State Physics. John Wiley & Sons, 8th edition (2005).
2. Ghatak Ajoy, Thyagarajan, Introduction to Fiber Optics, Cambridge University Press (2006).
3. Silvio R A, Salinass, Introduction to Statistical Physics, Springer Verlag (2004).
4. Lakhanpal R C, Modern Approach to Statistical Physics and Thermodynamics, Modern Publishers (2003).

Other useful resource(s):

1. Link to topics related to course:
   i. https://nptel.ac.in/courses/115101004/
   ii. https://nptel.ac.in/courses/115101005/
   iii. https://nptel.ac.in/courses/115105099/
   iv. https://nptel.ac.in/courses/122101002/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Engineering Physics-II)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	2				2		2	**2**
CO-2	2	3	3	3	3	2				2		2	**2.5**
CO-3	3	3	3	2	3	2				2		2	**2.5**
CO-4	2	3	3	3	2	2				3		3	**2.6**
CO-5	3	3	3	3	2	1				3		3	**2.6**
CO-6	3	3	3	3	2	1				3		3	**2.6**
Average	**2.5**	**2.8**	**2.8**	**2.7**	**2.3**	**1.7**				**2.5**		**2.5**	

Engineering Physics Lab-II

COURSE CODE: 18B17PH271

COURSE CREDITS: 1

CORE/ELECTIVE: CORE

: 0-0-2

Pre-requisite: None

Course Objectives:

1. The Art of Experimentation: The introductory laboratory engages each student in significant experiences with experimental processes, including some experience in investigation.
2. Experimental and Analytical Skills: The laboratory help the student develop a broad array of basic skills and tools of experimental physics and data analysis.
3. Conceptual Learning: The laboratory help student's to understand basic physics concepts.
4. Understanding the Basis of Knowledge in Physics: The laboratory help students understand the role of direct observation in physics and to distinguish between inferences based on theory and the outcomes of experiments.
5. Developing Collaborative Learning Skills: The laboratory helps students to develop collaborative learning skills that are vital to success in many lifelong endeavors.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO1	To Understand different aspects of magnetism and semi conductive properties of materials and their use in design of various devices.	Familiarity
CO2	To helps the students to understand the concepts of light propagation in optical fiber and introduce them to various losses in optical fiber communication.	Familiarity and Assessment
CO3	To demonstrate the scientific results based on observation.	Assessment and usage
CO4	Scientific discussion for clear and concise conclusion on particular scientific results.	Assessment and usage
CO5	To develop collaborative learning skills	Assessment and usage

List of Experiments:

S.No	Description	Hours
1	To determine the numerical aperture, of an optical fibre using LED as a light source.	**2**
2	To determine the attenuation coefficient, losses of an optical fiber	**2**
3	To measure resistivity of semiconductor using four probe methods.	**2**

4	To measure energy band gap of the Ge crystal using four probe methods and compare with optical band gap.	**2**
5	To study Hall effect in semiconductor and determination of its allied parameters.	**2**
6	To determine the carrier concentration and type of doping using hall coefficient.	**2**
7	To calculate the e/m ratio for an electron using Thomson method/Bar magnet method	**4**
8	To study magnetostriction in magnetic materials using He-Ne laser.	**4**
9	To study the coercivity, saturation magnetization, retentivity of given materials.	**4**
10	Experimental Determination of Planck's constant using Light Emitting Diodes (LEDs) and Photoelectric Effect.	**4**
Total Lab hours		**28**

Suggested/Resources:

1. S. P. Singh, Advanced Practical Physics,Pragati Prakashan, Vol. 1 (2013).
2. C. L. Arora, Practical Physics, S. Chand Company Limited, 20th edition (2004).
3. N. Subrahmanayam, Brij Lal and M.N. Avadhanulu, A Text Book of Optics, S. Chand (2012)
4. Ajoy Ghatak, Optics, Tata McGraw Hill, 5th addition, (2012)
5. F.A. Jenkins and H.E. White, Fundamentals of Optics, McGraw-Hill (1981).
6. Dabir S. Viswanath, Tushar Ghosh, Dasika H.L. Prasad, Nidamarty V.K. Dutt, Kalipatnapu Y. Rani , Viscosity of Liquids: Theory, Estimation, Experiment, and Data , Springer (2007).

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Attendance	15 Marks
4	Lab Assessment	45 Marks
	Total	100 marks

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Average
CO1	3	3	3	3	2	2	1	1	3	1	1	1	**2.00**
CO2	3	3	3	3	2	2	1	1	3	1	1	1	**2.00**
CO3	3	3	3	3	2	2	1	1	3	1	1	1	**2.00**
CO4	2	2	2	2	2	2	1	1	1	1	1	1	**1.5**
CO5	2	2	2	2	2	2	1	1	1	1	1	1	**1.5**
Average	**2.6**	**2.6**	**2.6**	**2.6**	**2.0**	**2.0**	**1.0**	**1.00**	**2.2**	**1.00**	**1.0**	**1.0**	

Engineering Physics Lab-I

COURSE CODE: 18B17PH171

COURSE CREDITS: 1

CORE/ELECTIVE: CORE

: 0-0-2

List of Experiments:

S.No	Description	Hours
1	To determine the wavelength of sodium light by measuring the diameters of Newton's Rings	4
2	To find the wavelength of sodium light using Fresnel's biprism.	2
3	To determine the distance between two virtual source using biprism.	2
4	To measure the wavelengths of certain lines in the spectrum of the mercury lamp using plane transmission grating.	2
5	To determine the dispersive power of the material of prism with the help of a spectrometer.	2
6	To measure the angle of prism with the help of a spectrometer.	2
7	To determine the magnetic susceptibility of a given paramagnetic liquid using Quinck's method.	4
8	To find the specific rotation of sugar solution by using a half shade polarimeter.	4
9	To find the specific rotation of sugar solution by using a biquartz polarimeter.	4
10	To verify the Malus's law for a given light using polarizer and analyzer.	2
Total Lab hours		**28**

Suggested/Resources:

1. S. P. Singh, Advanced Practical Physics,Pragati Prakashan, Vol. 1 (2013).
2. C. L. Arora, Practical Physics, S. Chand Company Limited, 20th edition (2004).
3. N. Subrahmanayam, Brij Lal and M.N. Avadhanulu, A Text Book of Optics, S. Chand (2012)
4. Ajoy Ghatak, Optics, Tata McGraw Hill, 5th addition, (2012)
5. F.A. Jenkins and H.E. White, Fundamentals of Optics, McGraw-Hill (1981).
6. Dabir S. Viswanath, Tushar Ghosh, Dasika H.L. Prasad, Nidamarty V.K. Dutt, Kalipatnapu Y. Rani , Viscosity of Liquids: Theory, Estimation, Experiment, and Data , Springer (2007).

Electrical Science

COURSE CODE: 18B11EC211

COURSE CREDITS: 4

CORE/ELECTIVE: CORE

: 3-1-0

Pre-requisite: None

Course Objectives:

1. To introduce various circuit elements.
2. To analyze different DC and AC circuits using various circuittheorems.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Understand the basic parameters related to DC and AC circuit.	Familiarity
CO-2	Understanding electrical principle, laws, and working of electrical machines.	Familiarity
CO-3	Understanding different theorems to analyze DC and AC circuits.	Usage
CO-4	Understanding sinusoidal steady state analysis of various AC circuits.	Usage
CO-5	Demonstrate knowledge of and apply the theory of transformers and induction motors.	Assessment

Course Contents:

Unit	Contents	Lectures required
1	DC Circuits: Electrical circuit elements (R, L and C), Voltage and current sources, series and parallel combination of elements, star and delta connections, Kirchhoff current and voltage laws, analysis of simple circuits and dc excitation using Node and Mesh analysis. Superposition, Thevenin and Norton Theorems. Time-domain analysis of first-order RL and RC circuits	9
2	AC Circuits: Representation of sinusoidal waveforms, peak and rms values, phasor representation, real power, reactive power, apparent power, power factor. Analysis of single-phase AC circuits consisting of R, L, C, RL, RLC combinations (series and parallel), resonance.	9
3	Sinusoidal steady state analysis: Representation of sine function, Phasor diagrams, Impedance and admittances, AC circuit analysis, Effective or RMS values, Average power and Complex power.	8
4	Transformers: Magnetic materials, BH characteristics, ideal and practical transformer, equivalent circuit, losses in transformers, regulation and efficiency.	5
5	Electrical Installations: Types of wires and cables, earthling, types of batteries, important characteristics for batteries, elementary calculations for energy consumption, power factor improvement and battery backup.	5
6	Electrical Machines: Introduction to machines, single-phase induction motor, construction, working, loss components and efficiency, staring and speed control of induction motor.	6
Total lectures		42

Suggested Text Book(s):

1. W.H. Hayt, J. E. Kemerlay & S.M. Durbin: Engineering Circuit Analysis, 6th Ed., TATA McGraw Hill, 2006.
2. J. Hiley, K. Brown, & I.M. Smith: Electrical and Electronic Technology, 10th Ed., Pearson, 2019.
3. D.C. Kulshreshtha: Basic Electrical Engineering, 1st Ed., McGraw Hill Education, 2011.

Suggested Reference Book(s):

1. Ozgur Ergul: Introduction to Electrical Circuit Analysis, 1st Ed., Wiley , 2017.
2. V.N. Mittle and Arvind Mittal: Basic Electrical Engineering, 2nd Ed., Tata McGraw Hill,2015.

Other useful resource(s):

Link to NPTEL course contents: https://nptel.ac.in/courses/108102097/3 (Prof. S.C. Dutta Roy, IIT Delhi)

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Electrical Science)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	3	3	2	2	1	1	1	1	1	3	2
CO-2	3	2	2	2	3	2	1	1	1	1	2	3	1.92
CO-3	3	3	3	3	2	2	1	1	1	1	1	3	2
CO-4	3	3	3	3	2	2	1	1	1	1	1	3	2
CO-5	3	3	3	3	3	2	1	1	1	1	2	3	2.17
Average	3	2.8	2.8	2.8	2.4	2	1	1	1	1	1.4	3	

Electrical Science Lab

COURSE CODE: 18B17EC271

COURSE CREDITS: 1

CORE/ELECTIVE: CORE

L-T-P: 0-0-2

Pre-requisite: None

Course Objectives:

1. The primary objective of this course is to provide a thorough understanding of circuit analysis and measurement of various electrical parameters.
2. Analysis of a given circuit depending on types of elements - DC analysis, Transient analysis and Frequency analysis.
3. To acquire hands on experience of conducting various experiments on electrical machines.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO1	Understanding basic electrical sources and measuring devices: Power supply, Multimeter, CRO/DSO and Function Generator.	Familiarity
CO2	Understand the basic working principle of a transformer and the operation of electrical machines.	Usages
CO3	Practical implementation of the fundamental electrical theorems and modeling of simple electrical systems.	Usages
CO4	Accurate measurement of voltage, current, power and impedance of any circuit.	Usages
CO5	DC analysis, Transient analysis and Frequency analysis of a given circuit depending on types of elements.	Assessment
CO6	Teamwork skills for working effectively in groups and develop analytical skills to compare experimental results with theoretical concepts.	Assessment

List of Experiments

S.No	Description	Hours
1	Introduction to Power supply & Multimeter.	2
2	To determine the equivalent resistance of a circuit using color code and to verify it using a multimeter. To verify Voltage divider and Current divider.	2
3	To verify Delta to Star and Star to Delta conversion.	2
4	Introduction to CRO & Function Generator	2
5	To verify Kirchoff's voltage law (KVL) and Kirchoff's Current Law (KCL)	2
6	To verify Superposition Theorem	2
7	To verify Norton's Theorem	2
8	To verify Thevenin's Theorem and Maximum Power Transfer Theorem	2
9	To study the transient response of series RC circuits using different values and R and C	2
10	Determination of frequency response of current in RLC circuit with sinusoidal ac input	2
11	To determine the turns ratio and polarities of transformer windings.	2
12	To obtain the equivalent circuit parameters from OC and SC tests, and to estimate efficiency & regulation at various loads.	2
Total Lab hours		24

Approved in Academic Council held on 25.10.2018

Suggested Resources:

1. W.H. Hayt, J. E. Kemerlay & S.M. Durbin, “Engineering Circuit Analysis”, Eighth Edition, McGraw Hill, 2012.
2. Van Valkenburg, “Network Analysis”, Prentice-Hall India, 2001.
3. D.C. Kulshreshtha, “Basic Electrical Engineering”, First Edition, McGraw Hill, 2011.

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Attendance	15 Marks
4	Lab Assessment	45 Marks
	Total	100 marks

Course Outcomes (COs) contribution to the Program Outcomes (POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Average
CO1	3	3	3	2	2	2	3	1	1	1	1	1	1.92
CO2	3	3	3	2	3	2	1	1	1	1	1	1	1.83
CO3	3	3	2	3	2	3	2	1	1	1	2	1	2.00
CO4	3	3	3	2	3	2	1	1	1	1	1	1	1.83
CO5	3	2	3	3	3	2	1	1	1	1	1	1	1.83
C06	3	3	3	3	2	2	2	3	2	2	2	2	2.42
Average	3.00	2.83	2.83	2.50	2.50	2.17	1.67	1.33	1.17	1.17	1.33	1.17	

Embedded System Design

COURSE CODE:

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite:

None

Course Objectives:

To learn about the embedded system application areas, design challenges, design and development methodology, tools used for embedded system design, embedded system integration and testing.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Understand various components of embedded system, design challenges and design metrics	Familiarity
CO-2	Learn about embedded system programming through 8051 microcontroller, programming and I/O interfacing	Usage
CO-3	Comprehend RISC architecture, programming of ARM and PIC microcontrollers	Usage
CO-4	Know about embedded system design and development methodology, tools and languages used for embedded system design	Usage
CO-5	Learn about integration and testing of embedded systems	Assessment

Course Contents:

Unit	Contents	Lectures Required
1	Introduction: Embedded systems overview, Classification, Application areas, Design challenges – real-time execution, physical size, power consumption, multirate operation. Design metrics – time-to-market, unit cost, performance.	4
2	Typical Embedded System: Core of the embedded system, Sensors and actuators, Communication interface, Embedded firmware	6
3	8051 Microcontroller: 8051 Architecture, timers and interrupts, Special function registers, Program/ data memory, addressing modes. instruction set, interrupts,	8
4	ARM Processor Fundamentals and Architectures, ARM Instruction Set, PIC Microcontroller and its Architecture.	10
5	Design and Development of Embedded product: Analog Electronic Components, Digital Electronic Components, Electronic design automation tools, Embedded firmware design approaches, Embedded firmware development languages	8

6	Integration and testing of embedded hardware and firmware, Embedded system development environment, Product enclosure design and development, Embedded product development life cycle, Trends in embedded industry	6
Total		42

Suggested Text Book(s):

1. Frank Vahid and Tony Givargis, “Embedded system design: A unified Hardware/Software introduction,”3rd Ed., Wiley 2014
2. Shibu K. V, “Introduction to Embedded Systems,” 2nd Ed., McGraw Hill, 2017

Suggested Reference Book(s):

1. Steve Furber, “ARM System-on-Chip Architecture,” 2nd Ed., Pearson 2012
2. Tim Wilmshurst, “Designing Embedded Systems with PIC Microcontrollers: Principles and Applications,” 2nd Ed., Newnes, 2009
3. Steven F Barrett and Daniel J Pack, “Embedded Systems Design and Applications with the 68HC12 and HCS12,” 1st Ed., Pearson 2012
4. Kenneth Ayala, “The 8051 microcontroller,” 3rd Ed., Thomson, 2005

Other useful resource(s):

NPTEL ONLINE COURSES

1. Embedded Systems: https://nptel.ac.in/courses/108105057/ (Prof. A. Routray, Prof. Rajib Mall, Prof. Amit Patra, IIT Kharagpur)
2. Embedded Systems: https://nptel.ac.in/courses/108102045/ (Prof. Santanu Chaudhary, IIT Delhi)
3. Embedded Systems Design: https://nptel.ac.in/courses/106105159/ (Prof. Anupam Basu ,IIT Kharagpur)

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

CO/PO (Embedded System Design)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Average
CO1	2	X	2	1	2	X	X	X	X	X	3	1	0.92
CO2	3	3	3	2	3	2	X	X	2	3	X	3	2.00
CO3	3	2	3	2	3	2	X	X	1	2	X	2	1.67
CO4	3	2	3	2	3	2	X	X	1	X	X	2	1.50
CO5	3	2	3	2	3	2	X	X	X	X	X	2	1.42
CO6	3	2	3	2	2	3	X	X	2	2	1	1	1.75
Average	2.83	1.83	2.83	1.83	2.67	1.83	0.00	0.00	1.00	1.17	0.67	1.83	

English and Technical Communication

Course Goal

This course is aimed to equip students of engineering with effective oral and written communication. The course develops the verbal skills of the students with emphasis on learning grammatical concepts and syntactical strategies. The course emphasis in grooming the students and their personality by focusing on written and spoken English and Communication.

Course Objectives

- The Student will be able to analyze communication situations and audiences to make choices about the most effective and efficient way to communicate and deliver messages
- The student will learn to deliver effective presentations in contexts that may require power point, extemporaneous or impromptu oral presentations
- The student will learn to write grammatically correct business documents using appropriate business style.
- The student will learn to speak and write grammatically correct sentences with the ability to express thoughts with clarity and accuracy.
- Students will develop command over their language and synchronize their thoughts into written form

Detailed Syllabi
Lecture-wise Breakup

Subject Code	18B17HS171	**Semester**	1
Subject Name	English and Technical Communication		
Credits	03	**Contact Hours**	28

Faculty (Names)	**Coordinator(s)**	1.Dr Tanu Sharma 2. Dr. Papiya Lahiri
	Teacher(s) (Alphabetically)	

Module No.	Subtitle of the Module	Topics	No. of Lectures
1	Concept and Nature of Communication	What is communication? Stages of communication Ideation, encoding, transmission, decoding & response Channels of communication Communication in organizational settings Etiquettes in social and Office settings Work culture in Jobs Barriers to effective communication Guidelines to overcome communication barriers	4
2	Self Development and Assessment	Self Assessment,Awareness, Perception and Attitude and Values. Personal goal Setting ,	2
3	Effective presentation	Pre- presentation jitters Preparation and practice Delivering the presentation Qualities of a skilful presenter Capturing and maintaining attention Handling questions Power point presentations	4
4	Nature and Mechanics of Writing(Basic Writing Skills)	Techniques for writing precisely: Defining Describing Classifying Use of Phrases and Clauses in sentences Importance of Proper Punctuation Organizing Principles of Paragraphs in documents	5
5	Technical Writing	Importance ,structure and drafting and revising of Reports Technical writing style and Language Business writing: Letters, Preparing	6

		resume, notices, agenda and minutes of meeting	
6	Vocabulary Development	Word Formation Derivatives: Prefixes & Suffixes Root words Synonyms, Antonyms Homophones and Homonyms One word substitution	2
7	Grammar and Usage	Subject-Verb Agreement Noun-Pronoun Agreement Prepositions, Articles	3
8	Identifying Common errors in writing	Redundancies, Clichés , Misplace modifiers, words often confused and misused	2
		Total number of Lectures	28

Methodology

The course will follow an interactive teaching-learning method with classroom discussions and activities on fundamental concepts of grammar with a strong emphasis on skill development of students with regard to speaking, writing, logically interpreting ideas into words and reasoning in the classroom. Both lab and tutorial activities are run on student –teacher individual and group interactions.

Evaluation

Sr. No.	Components	Total Marks
1	**Test 1**	15
2	**Test 2**	25
3	**Test 3**	35
4	**Internal Assessment**	25

Recommended Reading (Books/Journals/Reports/Websites etc.: Author(s), Title, Edition, Publisher, Year of Publication etc. in IEEE format)	
1.	*Practical English Usage. Michael Swan. OUP.1995.*
2.	*Remedial English Grammar. F.T. Wood. Macmillan. 2007*
3.	*On Writing Well. William Zinsser. Harper Resource Book. 2001.*
5.	*Study Writing.Liz Hamp-Lyons and Ben Heasly. Cambridge University Press. 2006*
6.	*Communication Skills. Sanjay Kumar and Pushp Lata. OUP. 2011.*
7.	*Exercises in Spoken English. Parts. I-III. CIEFL, Hyderabad. OUP*
8.	*A Communicative Grammar of English. 3rd Edn. G. Leech and J. Svartvik. 2012*
9.	*Williams, K., Krizan, A. C., Logan, J. & Merrier, P. (2011) Business Communicating in Business 8th Ed. New Delhi: Cengage Learning.*
10.	*Murphy, Herta A., Herbert Hildebrandt, Jane Thomas (2008) Effective Business Communication 7th Ed. New Delhi:Tata Mcgraw Hill Education Private Limited.*
11.	*Guffey, M. A. (2000) Business Communication: Product & Process South-Western College Publishing.*
12.	*Lesikar, R. V., Flatley, M.E., Rentz, K. & Pande, N. (2009) Business communication 11th Ed. New Delhi: Mc Graw Hill.*
13.	*Business correspondence and Report Writing: by R. C. Sharma & Krishna Mohan*

English and Communication: Lab

Course Goal

The Presentation and Communication (Language Lab) aims at developing the verbal/written skills of the students with emphasis on learning grammatical concepts and syntactical strategies. The lab based softwares particularly focus on sharpening language skills of the students and grooming their personality. This would include expressing thoughts in the written form logically, precisely and appropriately; understanding the essentials of successful job applications with command over language and using economy of words; help in making communication stronger, facilitating working faster and better.

Course Objectives

1. The students will learn to speak and write grammatically correct sentences with the ability to express thoughts with clarity and accuracy.

2. The students will learn the rules of grammar in writing. It will enhance their ability to use logical sequencing while writing any business letter or document.

3. The students will learn using new words and build their vocabulary steadily and systematically by following the exercises.

4. Students will develop command over their language and synchronize their thoughts while writing different types and kinds of Business letters.

5. Students will be groomed to develop the art of speaking logically, confidently and pragmatically, involving understanding work ethics, manners and correct use of body language.

List of English and Communication Lab Exercises

Detailed Syllabi

Lab class-wise Breakup

Subject Code		**Semester**	1
Subject Name	Presentation and Communication (Language Lab)		

Credits	02	**Contact Hours**	28

Faculty (Names)	**Coordinator(s)**	1. Dr. Papiya Lahiri
	Teacher(s) (Alphabetically)	

Lab Exercise No.	**Subtitle of the Module**	**Topics**	**No. of Lab Exercises**
	The Writing Process	Key vocabulary for writing How do you write Vocabulary: What is a document The Writing process Prepositions The Writing process: some thoughts	1
	Linking Ideas (I)	Linking by time Linking by contrast and logic Test yourself (learn about sequencing, exemplifying, highlighting and logic)	1
	Linking Ideas (I)	Referencing Words (1) Practice linking ideas (using connectors) Grammatical focus (Agreement)	1
	Applying for a Job	Online Application (Spell Check) Use action words	1

		Resumes- the basics Look at a Resume Applying for a Job: a thought The Covering letter	
	Business Letters	Grammar focus: contractions A letter of complaint A letter of apology Words: formal or informal? (Writing clearly and appropriately)	1
	Writing letters	Successful emails: the basics (Alternatives to gender- specific words) Marketing emails: some thoughts Perfecting your document (Spell checking) Emails and letters: case studies (Analyze a formal response) Emails and Letters (Grammar Focus: Modals)	1
	Use of Body Language	This exercise will include showing a couple of videos to the students on the use of Body Language in communication and also how to interpret other people's body language when they communicate. This will include studying facial expressions, gestures, non- verbal cues and eye contact.	1
	Use of Power point	This exercise will comprise of two videos on the specifics of preparing	1

	presentation	power- point presentations; the Do's and don'ts; examples from successful business entrepreneurs' presentations.	
	Vocabulary Development	Synonyms, Antonyms, Standard Abbreviations One word Substitution Homophones, Homonyms, Paronyms, Words often confused and misused Word Functioning Idiomatically Foreign Words Prefixes Suffixes	2
	Reports: **Organizing Information**	What will I learn? Organizing information Why is organization important? Finding information Other Report types (Only reading) Write a report Grammar focus: past or present? (1) Grammar Focus: past or present? (2)	1
	Reported Speech	Introduction The Rule Practice: Pronouns Practice: Verbal Actions Pronunciation: Stress and Rhythm Do you understand	1

		Vocab: reporting verb Your test	
	Perfecting your Document (I)	What will I learn? The elements of formatting Format a document British or North American?	1
	Perfecting your Document (II)	Proofreading: grammar mistakes Practice Proofreading Spell Checking Common Misspellings Final thought: the golden rules	1
		Total	14

Methodology

The course will follow a lab based teaching-learning method with classroom discussions and activities on fundamental concepts of grammar with a strong emphasis on skill development of students with regard to speaking, writing, logically interpreting ideas into words and reasoning in the classroom. Both lab and tutorial activities are run on student –teacher individual and group interactions.

List of English and Communication Tutorial Classes

Sr No	Tutorial	Hr	Week
1	Introduction	1	1
2	Extempore Speaking	2	2 & 3
3	Extempore Speaking		
4	Prepared Speech	2	4 & 5
5	Prepared Speech		
6	Group Presentation	3	6,7, & 8
7	Group Presentation		
8	Group Presentation		
9	Group discussions	2	10 & 11
10	Group discussions		
11	Conversations, Debates and Dialogues	2	11 & 12
12	Conversations, Debates and Dialogues		
13	Summary, Precis writing, Essay writing	2	13 & 14
14	Summary, Precis writing, Essay writing		

Evaluation Scheme

1. Mid Sem Evaluation	20 Marks
2. End Sem Evaluation	20 Marks
3. Attendance	15 Marks
4. Class response	30 Marks
5. File	15 Marks
Total Marks	100 Marks

Recommended Reading (Books/Journals/Reports/Websites etc.: Author(s), Title, Edition, Publisher, Year of Publication etc. in IEEE format)	
1.	*Practical English Usage*. Michael Swan. OUP.1995.
2.	*Remedial English Grammar*. F.T. Wood. Macmillan. 2007
3.	*On Writing Well.* William Zinsser. Harper Resource Book. 2001.
5.	*Study Writing.*Liz Hamp-Lyons and Ben Heasly. Cambridge University Press. 2006
6.	*Communication Skills.* Sanjay Kumar and Pushp Lata. OUP. 2011.
7.	*Exercises in Spoken English.* Parts. I-III. CIEFL, Hyderabad. OUP
8.	*A Communicative Grammar of English.* 3rd Edn. G. Leech and J. Svartvik. 2012

Finance and Accounting

COURSE CODE: 18B11HS411

COURSE CREDITS: 3

CORE/ELECTIVE: CORE

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

1. Understand the issues and framework of accounting and corporate finance.
2. Prepare financial statements.
3. Analyze financial statements using different techniques.
4. Analyze projects, its financial needs, financial performance and design a suitable strategy in case of conflicting recommendations.
5. Make optimal financial decisions on sustainable basis, not only for the firm but also for the society at large.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Understand the basic concepts of accounting and finance and their interrelationships	Familiarity
CO-2	Prepare different types of financial statements from Journal to Balance Sheet.	Assessment
CO-3	Analyze financial statements using different tools and techniques and hence be able to calculate the value of the firm.	Assessment
CO-4	Calculate financing needs of the firm, effects of time on value of money, availability of finances and their costs, requirement of mix of finances, evaluation of projects	Usage
CO-5	Apply the concepts and make optimal decisions	Usage

Course Contents:

Unit	Contents	Lectures required
1	**Introduction to Accounting:** Basic concepts of accounting, Accounting standards and Policies, Accounting Concepts and Conventions. Accounting Equation, Preparation of Journal, Ledger and Trial Balance	6
2	**Preparations of Final Accounts:** Understanding adjustments, Preparation of Final Accounts – Trading, Profit and Loss, Balance Sheet, Use of MS-Excel for financial statement analysis	6
3	**An Overview of Financial Management:** Nature and scope of financial management, Role of finance function, Finance decisions of the firm, Objective function in finance, Agency costs and corporate governance, Financial management and accounting, Financial objectives and organizational strategy	2
4	**Comparative and Historical Analysis:** Analyzing financial statement – Ratio Analysis – liquidity ratios, capital structure ratios, working capital ratios, profitability ratios, valuation ratios, Interlinking the ratios- Dupont analysis, Uses and limitations of ratio analysis	5
5	**Sources of Finance:** Role of financial markets, Financial Markets- segments, products and services, Long-term sources of finance - Equity, Debt, Debentures/Bonds	2
6	**Time Value of Money:** Basics of time value, Finding future value, Discounting and present value, Future value of annuity,, Present value of annuity, Periodicity of compounding and discounting, Equated monthly installments	3
7	**Cost of Capital:** Opportunity cost of capital, Weighted average cost of capital	3

	(WACC), Cost of Debt, Cost of preference capital, Cost of equity, Assigning weights, WACC, Factors affecting cost of capital	
8	**Capital Structure – Theory:** Common assumptions for analysis, Net income approach, Net operating income approach, Traditional approach, MM theory without and with corporate taxes, Leverage and financial distress, Trade-off theory, Pecking order theory.	**2**
9	**Designing Capital Structure:** Operating leverage, Financial leverage, EBIT-EPS analysis, ROI-ROE analysis, Defining target/ optimal capital structure	**3**
10	**Capital Budgeting:** Features of capital budgeting decisions, Types of projects, Techniques of evaluation of capital budgeting decisions, Accounting rate of return, Payback period method, Net present value method, Internal rate of return, NPV and IRR – A comparison, Conflict between IRR and NPV, Advantages of NPV and IRR, Modified IRR, Projecting cash flows, Principles of cash flow projections, Cautions in capital budgeting and cash flow projection.	**6**
11	**Working Capital Management:** Meaning of working capital, Scope of working capital management, Working capital needs of different types of businesses, Operating cycle and its relevance for WCM, Working capital financing policies, Working capital policy, Estimation of working capital requirements.	**4**
Total Lectures		**42**

Suggested Text Book(s):

1. P. C. Tulsian: Financial Accounting, Pearson Education
2. Rajiv Srivastava and Anil Misra: Financial Management, 2nd Edition, Oxford University Press
3. I. M. Pandey: Financial Management, 9th Edition, Vikas Publishing House

Suggested Reference Book(s):

1. V. Rajasekaran and R. Lalitha, Financial Accounting, Pearson Accounting
2. E. F. Brigham: Fundamentals of Financial Management, Thomson Learning
3. Sheeba Kapil: Financial Management, Pearson Education

Other useful resource(s):

1. Link to NPTEL course contents:
   https://nptel.ac.in/courses/110101003/
   https://nptel.ac.in/courses/110107073/
   https://nptel.ac.in/courses/110104066/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Class Performance - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Finance and Accounting)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average

CO-1	0	1	1	1	1	1	1	0	1	0	1	1	0.75
CO-2	0	2	2	2	2	1	0	1	2	0	3	2	1.42
CO-3	0	3	2	3	2	0	1	0	2	0	3	1	1.42
CO-4	0	3	3	3	3	1	1	0	2	1	3	1	1.75
CO-5	0	3	3	3	3	1	1	0	2	0	3	2	1.75
Average	0	2.4	2.2	2.4	2.2	0.8	0.8	0.2	1.8	0.2	2.6	1.4	1.4

Fundamentals of Digital Image Processing

COURSE CODE: 18B1WEC536

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

1. Describe and explain basic principles of digital image processing.
2. Design and implement algorithms for basic and advanced image analysis
3. Assess the performance of image processing algorithms and systems.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Analyze general terminology of digital image processing.	Familiarity
CO-2	Examine various types of images, intensity transformations and spatial filtering.	Familiarity
CO-3	Develop Fourier transform for image processing in frequency domain.	Assessment
CO-4	Evaluate the methodologies for image segmentation, restoration etc.	Usage
CO-5	Implement image process and analysis algorithms.	Usage
CO-6	Apply image processing algorithms in practical applications.	Usage

Course Contents:

Unit	Contents	Lectures required
1	Digital Image Fundamentals: Introduction, Image sensing and acquisition, Image Sampling and quantization, Spatial and Gray level resolution, Zooming and Shrinking, Relationships between pixels, Linear and Nonlinear operations.	7
2	Image Enhancement in the Spatial Domain: Gray Level Transformation, Histogram Processing Techniques, Basics of Spatial Filtering, Smoothing and Sharpening Spatial Filters.	8
3	Image Enhancement in the Frequency Domain: Properties of frequency domain, two dimensional Fourier Transform and its properties, Correspondence between filtering in spatial and frequency domain, Smoothing and Sharpening frequency domain filters, Homomorphic Filtering.	6
4	Image Restoration: Model of the Image Degradation/Restoration Process, Noise Models, Noise reduction in spatial domain and frequency domain, Inverse filtering, Wiener filtering.	6
5	Image Compression: Fundamentals of image compression, Image compression models, Variable length coding, Huffman coding, Near optimal variable length coding, Arithmetic coding, Constant area coding, Run length coding, Image compression standards (JPEG, JPEG2000).	7
6	Image Segmentation: Detection of discontinuities (point, line edge), Edge Linking and Boundary Detection, Thresholding, Basic global Thresholding, Adaptive Thresholding, Region-Based Segmentation.	8
Total lectures		42

Suggested Text Book(s):

1. Rafael C. Gonzales, Richard E. Woods, “Digital Image Processing”, fourth Edition, Pearson Education, 2018.

Suggested Reference Book(s):

1. Anil K. Jain, “Fundamentals of Digital Image Processing”, First Edition, PHI Learning Pvt. Ltd, 2015.

2. Willliam K Pratt, “Digital Image Processing”, Fourth Edition, John Willey, 2007.
3. S.Sridhar, ”Digital Image Processing”, Second Edition, Oxford University Press, 2016
4. Rafael C. Gonzalez, Richard E. Woods, Steven L. Eddins, “Digital Image Processing Using MATLAB”, Third Edition Tata Mc Graw Hill Pvt. Ltd., 2011.

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Fundamentals of Digital Image Processing)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	2	2	2	2	2	1	1	2	2	2	2	1.92
CO-2	3	3	3	3	3	1	1	1	2	2	1	2	1.08
CO-3	3	2	2	2	3	2	1	1	2	2	1	2	1.92
CO-4	3	3	3	3	2	1	1	1	2	3	2	2	2.17
CO-5	3	3	2	3	2	2	2	2	2	3	3	2	2.42
CO-6	3	2	3	3	2	2	2	1	2	2	3	2	2.00
Average	3.00	2.50	2.50	2.67	2.3	1.67	1.33	1.17	2.00	2.33	2.00	2.00	

Fundamentals of Digital Signal Processing & Applications

COURSE CODE: 18B1WEC636

COURSE CREDITS: 2

CORE/ELECTIVE: ELECTIVE

L-T-P: 2-0-0

Pre-requisite: Prerequisites are Higher Engineering Mathematics, Different Transforms (Fourier, Laplace & Z - transforms), Basic knowledge of Signals and Systems.

Course Objectives:

1. Learn to represent signal in time domain.
2. Learn to analyze the representation of signal in frequency domain.
3. Learn to study the signal transformation tools like Fourier transform, Laplace transform and Z – transform.
4. To study the architectural features of DSP processor.
5. Learn to design a signal processor (digital filter) for a given problem.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Analyze the interpretation of discrete/digital signals	Familiarity
CO-2	Study the frequency domain behavior of discrete / digital signals	Assessment
CO-3	Analysis and design of DSP filters	Assessment
CO-4	Study of application domains.	Usage

Course Contents:

Unit	Contents	Lectures required
1	Introduction to Digital Signal Processing (DSP): Discrete-time sequences and systems, Properties of discrete time sequences and systems, Frequency domain representation of discrete time sequences and its analysis, Sampling theorem and reconstruction of band limited signals.	5
2	Linear Time Invariant (LTI) System: Discrete time LTI system and its analysis, Impulse Response and Convolution Sum, Properties of LTI system, Correlation of Discrete time sequences, LTI system defined by Linear Constant Coefficient Difference Equations.	5
3	Review of Z - transform: Z Transform and its properties, Region of Convergence (ROC) and Pole-Zero Plot, Analysis of discrete LTI systems using Z Transform, Causality and Stability Criterion.	5
4	Discrete Fourier Transform (DFT) & Fast Fourier Transform (FFT): Sampling in frequency domain and origin of DFT, Properties of DFT, Linear Convolution using DFT, Analysis of discrete LTI systems using DFT, FFT-Efficient Computation of DFT, Goertzel Algorithm, radix - 2 Decimation-in-Time and Decimation-in-Frequency FFT Algorithms.	6
5	DSP Filter Design and Realization: Structures for the Realization of Discrete time systems, Structures for FIR and IIR systems, Design of FIR filters, Design of IIR filters from analog filters, Frequency Transformations.	6
6	Applications of DSP: Applications of DSP in Speech Processing, RADAR systems, Image Processing and Biomedical Engineering.	3
Total lectures		30

Suggested Text Book(s):

1. A. V. Oppenheim, R. W. Schafer, and J. R. Buck, Discrete-Time Signal Processing, 2nd Edition, Pearson Education, 2008.

2. S. K. Mitra and Yonghong Kuo, Digital Signal Processing: A Computer-based Approach, 2nd Edition, Tata McGraw-Hill, 2011.

Suggested Reference Book(s):

1. J. G. Proakis and D. G. Manolakis, Digital Signal Processing: Principles, Algorithms and Applications. Pearson Education India, 2011.

Other useful resource(s):

Link to topics related to course:

i. https://nptel.ac.in/courses/117102060/
ii. https://www.tutorialspoint.com/digital_signal_processing/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Fundamentals of DSP & Applications)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	3	3	2	1	2	2	2	2	2	2	2.08
CO-2	1	2	2	1	2	2	1	1	3	2	1	1	1.58
CO-3	1	3	3	3	1	2	2	1	3	3	1	2	2.08
CO-4	2	3	2	1	1	1	2	2	2	3	2	1	1.83
Average	1.5	2.5	2.5	2	1.5	1.5	1.75	1.5	2.5	2.5	1.5	1.5	

Fundamentals of Digital Signal Processing Lab

COURSE CODE: 18B1WEC673

COURSE CREDITS: 1

CORE/ELECTIVE: ELECTIVE

L-T-P: 0-0-2

Pre-requisite: Basic knowledge of MATLAB Programming for generation of signals and system analysis.

Course Objectives:

The objective of this course is to provide a thorough understanding and analysis of digital signal processing systems using MATLAB and LabVIEW.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO1	Understand the basics of Lab VIEW Programming and code compressor studio.	Familiarity
CO2	Generate the discrete time signals using sampling and conversion of analog signals in to digital signals.	Familiarity
CO3	Analyze the FFT Algorithm based frequency domain representation.	Usage
CO4	Design the FIR and IIR filter for specified parameters.	Usage
CO5	Apply the adaptive filtering for systems identification.	Assessment
CO6	Perform the linear and circular convolution using DSP kit to get the LTI system response..	Assessment

List of Experiments

S.No	Description	Hours
1	Getting Familiar with LabVIEW.	1
2	Generate a discrete signal by sampling a sinusoidal signal and I investigate the aliasing effect.	1
3	Convert analog signal to digital signal (A/D) and digital signal to analog signal (D/A) using LabVIEW	1
4	Design FIR filter using LabVIEW to meet specifications on their frequency response using window design.	1
5	Design IIR Filter using LabVIEW to meet specifications on their frequency response using the bilinear transformation.	1
6	Use LabVIEW to analyze and display signals in the frequency- domain using the FFT algorithm.	1
7	Design an adaptive filter for system identification using LabVIEW.	1
8	Getting familiar with code compressor studio.	1
9	Perform and verify linear convolution of two signals using DSP Kit.	1
10	Perform and verify circular convolution of two signals using DSP Kit.	1
Total Lab hours		10

Suggested/Resources:

1. T. H Cormen, C E Leiserson, R L Rivest and C Stein: Introduction to Algorithms, 3rd Edition, Prentice-Hall of India, 2010.
2. Kenneth A. Berman, Jerome L. Paul: Algorithms, Cengage Learning, 2002.

3. Ellis Horowitz, Sartaj Sahni, S.Rajasekharan: Fundamentals of Computer Algorithms, 2nd Edition, Universities press, 2007
4. https://nptel.ac.in/courses/106104019/26
5. https://nptel.ac.in/courses/106104019/2Ev

Evaluation Scheme:

1	Mid Sem. Evaluation (P-1)	20 Marks
2	End Sem. Evaluation (P-2)	20 Marks
3	Attendance	15 Marks
4	Lab Assessment	45 Marks
	Total	100 marks

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Average
CO1	3	3	3	3	2	2	1	1	1	1	1	1	1.83
CO2	3	3	3	3	3	1	1	1	1	1	1	3	2.00
CO3	3	3	2	3	2	3	2	1	1	1	2	1	2.00
CO4	3	3	3	2	3	2	1	1	1	1	1	1	1.83
CO5	2	2	3	3	3	3	1	1	1	1	1	1	1.83
C06	2	3	3	3	2	2	2	2	2	2	2	2	2.25
Average	2.67	2.83	2.80	2.80	2.60	2.20	1.20	1.00	1.00	1.00	1.20	1.40	

DEPARTMENT OF BIOTECHNOLOGY & BIOINFORMATICS

Course Title General Microbiology **(Core Course)**

Course Code 18MS1BT111

	L	T	P
Course Credit 3	3	0	0

Course Coordinator

Course Objectives

To acquaint the students with the development and techniques of microbiology useful in biotechnology industry**.** Scientific evaluation of various characteristics of microorganisms, their metabolism and role in various domains of life.

Course Assessment

Assessment	Max. marks	Duration	Course Covered
T1 Test	15	1 hr.	course covered upto T1
T2 Test	25	1.5 hrs.	course covered upto T2, including that covered upto T1
End Term Test	35	2 hrs.	Whole Syllabus
Teacher Assessment (Based on Assignments, quizzes etc.)	25	Entire semester	Information to be provided to the class time to time
Total	**100**		

Course Outcomes

CO I	To acquire the principles of Microbiology and fundamental concepts related to microbial classification and methods
CO II	Scientifically test the hypothesis provided under a given situation involving microbial world and demonstrate practical skills in basic microbiological techniques including growth and control of microorganisms.
CO III	Analyze and interpret the experiments/pathways relevant to Microbes
CO IV	Designate vital role of the microorganisms in the environment and their genetics and association with human beings.
CO V	Retrieve and use cotemporary information and industrial potential related to microbial world.

Topic Covered

S. No.	Unit	Topics Covered	Contact

			Hrs.
1	**Introduction of Microbiology and Historical Perspective**	Discovery of microbial world, Landmark discoveries relevant to the field of microbiology, Controversy over spontaneous generation, History and pioneers in Microbiology, Nomenclature and classification of microbes, Bacterial metabolism, Sterilization and disinfection, Role of microorganisms in transformation of organic matter and in the diseases	5
2	**Methods in Microbiology**	Isolation, description and identification of bacteria. Microscopy and Morphology of micro-organisms, Pure culture techniques, Theory and practice of sterilization, Principles of microbial nutrition, Enrichment culture techniques for isolati of microorganisms, Growth and nutrition of bacteria,	3
3	**Microbial Taxonomy and Diversity**	Bacteria, Archaea and their broad classification, Eukaryotic microbes: Yeasts, molds and protozoa, Viruses and their classification, Molecular approaches to microbial taxonomy	3
4	**Microbial Growth And Control of microorganisms**	Definition of growth, Growth curve, Mathematical expression of exponential growth phase, Measurement of growth and growth yields, Synchronous growth, Continuous culture, Effect of environmental factors on growth, Effect of physical and chemical agents, Evaluation of effectiveness of antimicrobial agents	7
5	**Microbial Metabolism**	Energetics: redox reactions and electron carriers, An overview of metabolism, Glycolysis, Pentose-phosphate pathway, Entner-Doudoroff pathway, Glyoxalate Pathway, The citric acid cycle, Fermentation, Aerobic and anaerobic respiration, Chemolithotrophy	7
6	**Microbial Diseases**	Human diseases caused by viruses, bacteria, and fungi; The epidemiology, pathogenesis, antigenic characteristics and laboratory diagnosis of disease The nature and Classification of viruses, Morphology virus structure, replication The genetics of viruses The pathogenicity of viruses Epidemiology of viral infections, Vaccines and antiviral drug	5
7	**Microbial Genetics**	Types of mutation, UV and chemical mutagens, Selection of mutants, Ames test for mutagenesis, Bacterial genetic system: transformation, conjugation, transduction, plasmids, transposons, DNA repair, Regulation of gene expression: repression and induction, Operon model, Bacterial genome with special reference to *E. Coli*, Retroviruses	7
8	**Microbial Ecology And Industrial applications**	Thermophiles, Alkaliphiles, Acidophiles, Halophiles, Psychrophies, Radiophiles, Fermented foods and beverages, Biofertilizers, Biopesticides, Biofuels and Bioenergy	5
	Total Number of Lectures		42

Methodology

The course will be covered through lectures. Apart from discussions on topics covered in lectures, assignments and numerical problems will also be given.

TEXT BOOKS

1	Prescott, Harley and Klein: Microbiology, 6th Edition, McGraw Hill 2005.
2	Pelczar, Chan and Krieg: Microbiology by; Tata McGraw Hill.

REFERENCE BOOKS

1	Madigan, M.T., Martinko, J.M., Parker, J: Brock Biology of Microorganisms. 10th Edition.: Publisher: Prentice Hall
2	Gerard J. Tortura, Berdell R. Funke, and Christine L: Microbiology An Introduction: Case. 8th Ed., Pearson/Benjamin Cummings, 2004.
3	Nester : Microbiology Study Guide McGraw Hill.
4	Black : Microbiology : Principles and Applications Prentice Hall
5	Principles of Population Genetics by Daniel L. Hartl and Andrew G. Clark

Molecular genetics and Genomics

COURSE CODE 18MS1BT112

COURSE CREDITS: 3
CORE/ELECTIVE: CORE
L-T-P: 3-0-0

Pre-requisite: Molecular Biology, Biochemistry, Microbiology

Course Objectives

1. This is an advance course with objective expose students to the advanced topics of Molecular Cell Biology
2. Application of molecular biology and genetics in prognosis, diagnosis and understanding of human diseases

Course Outcomes

S.No.	Course Outcomes	Level of Attainment
CO-1	Students will have a thorough understanding elements of biomolecules (DNA, RNA and protein)	Familiarity
CO-2	The students will know the vast amount of genome information in publically available databases and how to access and best utilize for practical purposes & sequencing, genome annotation, global gene cloning and gene expression technologies, comparative genomics, introduction to pharmacogenomics	Assessment

CO-3	Able to analyze the gene expression data sets to derive the biologically meaning information	Assessment
CO-4	Able to apply the knowledge of function genomics in public health	Usage

Topic Covered

S. No.	Contents	Lecture required.
1	Introduction to Genetics, Genome, Transcriptome, Proteome	3
2	DNA: The Genetic Material. Genome. Replication, Unique aspects of eukaryotic replication, fidelity of replication, DNA damage, repair mechanisms, homologous and site-specific recombination,	6
3	Gene Expression: Transcriptome, Eukaryotic RNA polymerases, RNA synthesis and RNA processing in eukaryotes, RNA editing, splicing, and polyadenylation. Traciptional factors (Crz1, AflR)	6
4	Gene Expression: Proteome. Aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetase, and translational proof-reading, translational inhibitors, Post-translational modification of proteins.	6
5	Genomics. Genetic and physical mapping. Understanding of a genome sequence, Prokaryotic and eukaryotic genomes. Organization of human genome. Organellar genome. Genome sequencing- Pyrosequencing & Sequencing by reverse termination. Application of whole of transcripts sequencing.	6
6	Functional and Comparative Genomics. Transcripts/transcriptome analysis-Hybridization and sequencing based approaches. Serial Analysis of Gene Expression-SAGE, DNA- Microarray, Application of DNA Microarray, RT-PCR, etc	6
7	Basics of population Genetics. Single Nucleotide polymorphism. SNP screening platforms & analysis. Haplotyping: Concepts and Applications. Genetics of cancer Biology- role of Tumor proteins p53, tumor suppressor p53, or transformation-related protein 53 (TRP53). p53 isoforms. Association studies of p53 gene in different setting of cancers.	6
8	Biomarker. Pharmacogenomics: Concepts and Applications in healthcare. Role of genotype in drug metabolism. Identification & Utilisation of cancer bio-marker	3
	Total Contact Hours	42

REFERENCE BOOKS

1. Molecular Cell Biology by Lodish
2. Molecular Biology, PS Verma VK Agarwal
3. Principles of genetics / D. Peter Snustad, Michael J. Simmons Snustad, D. Peter

4. Discovering Genomics, proteomics & bioinformatics. Second edition by A Malcolm Campbell, Davidson College; Laurie J. Heyer Davidson College ; With Foreword by Francis S. Collins
5. Molecular Biology of the Gene (1987) Watson J. D., Hopking N., Robast J. and Steiz, J.

6. BIOINFORMATICS: A Practical Guide to the Analysis of Genes and Proteins (Third edition) Andreas D. Baxevanis & B. F. Francis Ouellette

Research and Review Articles:

1. Suggested Reference (s): Ronaghi M. Pyrosequencing sheds light on DNA sequencing. Genome Res. 2001
2. Jan;11(1):3-11. Review. PubMed PMID: 11156611
3. Schulze A, Downward J. Navigating gene expression using microarrays—a technology review. Nat Cell Biol. 2001 Aug;3(8):E190-5. Review. PubMed PMID: 11483980
4. Kim JB, Porreca GJ, Song L, Greenway SC, Gorham JM, Church GM, Seidman CE, Seidman JG. Polony multiplex analysis of gene expression (PMAGE) in mouse hypertrophic cardiomyopathy. Science. 2007 Jun 8;316(5830):1481-4. PubMed PMID: 17556586
5. MacBeath G, Schreiber SL. Printing proteins as microarrays for high-throughput function determination. Science. 2000 Sep 8;289(5485):1760-3. PubMed PMID: 10976071.
6. Shankar J, Wu TD, Clemons KV, Monteiro JP, Mirels LF, et al. (2011) Influence of 17b-Estradiol on Gene Expression of Paracoccidioides during Mycelia-to- Yeast Transition. PLoS ONE 6(12): e28402. doi:10.1371/journal.pone.0028402
7. Mary V. Relling, William E. Evans Nature. Author manuscript; available in PMC 2016 Jan 13.

Evaluation Scheme:

Assessment	Max. marks	Duration	Course Covered
T1 Test	15	1 hr.	Syllabus covered upto T-1
T2 Test	25	1.5 hrs.	Syllabus covered upto T-2
End Term Test	35	2 hrs.	Entire Syllabus
Teacher Assessment	25	Entire Sem	Based on Assignments, quizzes etc.

Molecular genetics and Genomics Laboratory

COURSE CODE 18MS7BT112

COURSE CREDITS: 2

CORE/ELECTIVE: CORE
L-T-P: 0-0-2

Pre-requisite: Molecular Biology, Biochemistry, Microbiology

Course Outcomes:

1. The course is intended to provide hand on experiments on comparative and functional genomics. Students will able to carry out both basic bioinformatics work and function genomics work.
2. The course will explore that how different advance molecular biology techniques unravel the understanding of diseases at genetic level

Course Outcomes:

Experiments covered:

Index

S.NO.	TITLE
1	Isolation of Genomic DNA from different organisms (prokaryotes, eukaryotes and higher eukaryotes).
2	Polymerase chain reaction
3	Detection of SNP through RFLP (Restriction Fragment Length Polymorphism).
4	Extraction of Total RNA from eukaryotic species.
5	Preparation of cDNA template from isolated RNA.
6	Pulsed Field Gel Electrophoresis (demonstration)
7	Designing of Primers from a given gene of interest using online tools.
8	Physical restriction mapping of gene of interest (In-silico).
9	Real-Time PCR to quantify expression of gene.

Reference books **& Laboratory Manuals**

1. Methods in Molecular Biology. Starkey, Michael P. Elaswarapu, Ramnath. Genomics Protocols. 2000. Vol.

CO I	Students will have a thorough understanding of various genomic technologies SNP,, cDNA-PCR, etc
CO II	The students will know the vast amount of genome information in publically available databases and how to access and best utilize for practical purposes e.g., NCBI. DDBJ, EMBL.
CO III	Able to analyze the gene expression experimental data sets to derive the biologically meaning information
COIV	Identify, formulate, review research literature, and analyze complex
COV	Able to identify, formulate, review research literature, and analyze complex and asses health, safety, legal and issues

175. Humana Press
2. Sambrook, J., Fritsch, E. F., Manitiatis, T., Molecular Cloning: A Laboratory Manual, New York: Cold Spring Laboratory Press, 1998, 25—27.
3. Current Protocols in Molecular Biology. Frederick M. Ausubel. John Wiley & Sons Inc. 1988

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Lab Assessment	60 Marks

	Total	100 marks

Biochemistry and Intermediatery Metabolism

COURSE CODE 18MS1BT113

COURSE CREDITS: 3
CORE/ELECTIVE: CORE
L-T-P: 3-0-0

Pre-requisite: Cell Biology, structural biology, chemistry

Course Objectives

1. This is an advance course with an objectiveto provide an understanding of the various biomolecules and their chemical properties.
2. This course also has an objective to learn the interaction of bio-chemicals and their consequences on maintenance of life supporting processes.

Course Outcomes: In the end of the course, student will be able…..

S.No.	Course Outcomes	Level of Attainment
CO-1	to understand the fundamentals of various basic biomolecules present in organisms and their chemical structures.	Familiarity
CO-2	to understand the structural-functionalrelationship of biomolecules for sustainment of life processes.	Assessment
CO-3	to understand the metabolic pathways ofenergy production in living organism.	Assessment
CO-4	to understand the integration and regulation of various metabolic pathways of organism for maintenance of life supporting processes.	Usage

Topic Covered

	Contents	Lecture required.
1	General aspects of metabolism: Characteristics of metabolic pathways; Strategies used to study metabolic pathways, Laws of thermodynamics; Equilibrium constant and standard free energy change; Biological oxidation-reduction reactions; Standard reduction potential and its relationship with free energy change,	3
2	Carbohydrate Metabolism: Digestion and absorption of carbohydrates; Glycolysis; Entry of other monosaccharaides in glycolytic pathway; Gluconeogenesis; Citric acid cycle; Pentose phosphate pathway; Glucuronate pathway; Biosynthesis of lactose; Biosynthesis of oligosaccharides and glycoproteins; Glycogen metabolism and its regulation; Glycogen storage diseases and other genetic defects in	8

	carbohydrate metabolism; Regulation of carbohydrate metabolism; Metabolic adaptation in starvation and diabetes mellitus,	
3	Mitochondrial ATP Synthesis; Electron carriers and their organization; Sequence of respiratory complexes; ATP synthase and mechanism of ATP synthesis Transport of equivalents of NADH produced in cytoplasm; FADH2 oxidation. Oxidative phosphorylation: Sites of phosphorylation; Inhibitors and uncouplers; Energetics and regulation of oxidative phosphorylation.	6
4	Plant-Specific Metabolic Pathways; General pathways: Photosynthesis and carbon fixation; Glyoxylate pathway	6
5	Lipid Metabolism; Major dietary lipids; Digestion and absorption of dietary lipids; Pathways of fatty acid oxidation; Oxidation of odd carbon number and unsaturated fatty acids; Significance and metabolism of ketone bodies; Biosynthesis of saturated and unsaturated fatty acids; Metabolism of triacylglycerols, glycerolipids, sphingolipids and cholesterol; Role of leptin in the regulation of lipid metabolism.	7
6	Amino Acid and Porphyrin Metabolism; Digestion of dietary proteins; General reactions in the degradation of amino acids; Essential and nonessential amino acids; Deamination and transamination reactions; Urea cycle; Glucogenic and ketogenic amino acids;	6
7	Nucleotide and Xenobiotic Metabolism; Degradation of nucleic acids: deoxyribonucleases and ribonucleases; Biosynthesis and degradation of purine and pyrimidine nucleotides.	6
	Total Contact Hours	42

REFERENCE BOOKS

7. Lehninger Principles of Biochemistry by David L. Nelson and Michael M. Cox
8. Harpers Illustrated Biochemistry by by Victor W. Rodwell, David A Bender, Kathleen M. Botham, Peter J. Kennelly, P. Anthony Weil
9. Lippincott Illustrated Reviews: Biochemistry by Denise R. Ferrier

EvaluationScheme:

Assessment	Max. marks	Duration	Course Covered
T1 Test	15	1 hr.	Syllabus covered upto T-1
T2 Test	25	1.5 hrs.	Syllabus covered upto T-2
End Term Test	35	2 hrs.	Entire Syllabus
Teacher Assessment	25	Entire Sem	Based on Assignments, quizzes etc.

Biochemistry and Metabolism lab.

COURSE CODE 18MS7BT113

COURSE CREDITS: 2
CORE/ELECTIVE: CORE
L-T-P: 0-0-2

Pre-requisite: Cell Biology, chemistry
Course Outcomes:

1. The course is intended to provide hand on experiments on biochemistry. Students will able to carry out both qualitative and quantitative estimation of basic biomolecules of living organisms.
2. The course will also explore that how different advance biochemistry methods unravel the understanding and diagnosingvarious diseases at molecular level.

Course Outcomes: In the end of the course, student will be able…..

Experiments covered:

S.NO.	TITLE
1	Spectroscopic analysis of various biomolecules and determination of absorption spectrum,
2	Isolation of polysaccharide (starch or glycogen) from the biological material,
3	Quantitative estimation of carbohydrate using biochemical methods,
4	Extraction of lipid/oil from plant material and determination of its saponification value and iodine number,
5	Estimation of phospholipids by Stewart's method,
6	Estimation of protein and sugar content of a glycoprotein;
7	Sub – cellular fraction of and isolation of nuclei and mitochondria from the tissue and identification by the marker enzymes,
8	Determination of molecular weight of proteins by gel filtration,
9	Poly-acraylamide Gel Electrophoresis of serum proteins,
10	Isoelectric focusing and 2D electrophoresis

S.No.	Course Outcomes	Level of Attainment
CO I	To familiarize with basic biochemistry laboratory procedures and safety.	Familiarity
CO II	To identify different biochemical molecules using basic biochemical tests estimate their quantity in standard units.	Assessment
CO III	To quantitate the concentration of a biomolecule in given sample.	Assessment
COIV	To identify and analyze different bio-chemicals in different samples like body fluids, food material etc. and asses their information in relation to human health	Usage

11	Isolation and quantification of DNA from plant tissue.
12	Isolation and quantification of DNA from animal tissue.

1**Reference books and related material:**

1. Lab manual
2. An Introduction to Practical Biochemistry - David T Plummer
3. Practical Biochemistry, Principles and Techniques - Keith Wilson and John Walker
4. Practical Biochemistry-GeethaDamodaran K
5. E-portal of V-labs by Amrita University (vlab.amrita.edu)

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Lab Assessment	60 Marks
	Total	100 marks

Research Methodology and Inferential Statistics

COURSE CODE: 18MS1BT114

COURSE CREDITS: 3
CORE/ELECTIVE: CORE
L-T-P: 3-1-0

Pre-requisite: Nil

Course Objectives:

The Objective of the course is to make the student aware of research, planning design and appropriate methodology for research. They will learn statistical treatment, analysis of data, interpretation of results and report writing and assessment.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	The student will aware of ware of the finer nuances and significance of research, selecting, Defining and planning a research problem	Familiarity and Basics
CO-2	The student will learn various types of sampling methods suitable for statistical treatment and drawing valid inferences	Technical and strategies
CO-3	Develop understanding of measure of dispersion, tools and techniques of setting and validating scientific and statistical hypothesis	Technical and application
CO-4	Will learn different type experimental designs and principles of experimental designs	Technical and application
CO-5	Understand the importance scientific communication and technical writing skills	Familiarity and Basics

Course Contents:

Unit	Contents	Lectures required
1	**Fundamentals of Research and Research Process** Meaning and objectives of research, Importance of knowing research methods, Type of research, Basic research process, Criteria of good research, General conditions for a research problem, Selecting a research problem, Necessity and techniques of defining a problem	5

2	**Sampling and Sampling methods** Introduction, Definitions, aim of sampling, Type of populations, Different type of sampling methods	**4**
3	**Measure of Dispersion** Definition, methods of computation, merits, demerits uses and properties of different measures of central tendency. Definition, Computation, merits, demerits uses and properties of different measures of dispersion. Relative measure of dispersion, coefficient of variation, standard error, Central limit Theorem	**5**
4	**Testing of Hypothesis** Statistical hypothesis, critical region, level of significance, power of test, degree of freedom, steps in testing a hypothesis, Applications of z, t and Chi square tests for testing hypothesis, chi-square test, Application of chi-square test	**9**
5	**Analysis of Variance** Fundamental principles of analysis of variance, portioning sum of squares and degree of freedom, test of significance, critical difference, method of calculating sum of squares	**6**
6	**Principles of Experimental designs** Basic definitions; Experiment, treatment, replication, Experimental material, Experimental units, Fisher's principles of experimental design; Advantages of replication, randomization, local control; Precision and accuracy. Experimental Designs CRD, RBD & Latin Square	**9**
7	**Report writing, Interpretation and Assessment** Significance of report writing, steps in report writing, layout of research report, Types of reports, Mechanics of writing report, precaution for writing research reports, Technique and precautions in interpretation	**5**
Total lectures		**42**

Suggested Text Book(s):

1. Research Methodology: Methods and Techniques. CR Kothari, New Age International Publishers.
2. Biostaistics A Foundation For Analysis in Health Sciences: Wayne W. Daniel John Willey & Sons, INC
3. A handbook of Agricultural statistics: SRS Chandel Achal Prakashan Mandir

Suggested Reference Book(s):

1. An introduction to biostatistics A manual for students for health Sciences. P.S.S. Sundar Rao and J. Richard. Prentice Hall of India.
2. Introduction to biostatistics A textbook of Biometry. P. K. Banerjee. S Chand and company ltd

Other useful resource(s):

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination

1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment, Quizzes & Attendance

GLP and Bioinstrumentation

COURSE CODE: 18MS1BT115

COURSE CREDITS: 3
CORE/ELECTIVE: CORE
L-T-P: 3-0-0

Pre-requisite: B.Sc./B. Tech 2nd year completed

Course Objectives

3. The Objective of the course is to make the student aware of good laboratory practices and various regulatory guidelines followed in Biotech/Pharmaceutical industry
4. This course covers both theory and practical aspects of modern instrumentation used for analysis in biological research.

Course Outcomes

S.No.	Course Outcomes	Level of Attainment
CO-1	Able to understand basic guidelines and importance of good laboratory practice	Familiarity
CO-2	To learn various safety aspect related to laboratory research	Assessment
CO-3	To be able to understand documentation and conduct of non clinical studies	Assessment
CO-4	Able to Understand basic instrumental principles involved in the operation of mass spectrometers, infrared spectrometers,and nuclear magnetic resonance spectrometers.	Usage
CO-5	To Develop necessary critical thinking skills in order to do data analysis and interpretation in relation to the research process	Usage
CO-6	To analyze various analytical data	Usage

Topic Covered

S.	Contents	Lecture

No.		required.
1	Historical background of GLPs (The different organizations that have developed GLPs, Focus of each set of GLPs. Common GLP terms and definitions),	3
2	*Overview,Purpose and Essential elements of GLP :* Safety in the Laboratory: Material safety, Environmental safety, Occupational hazardous safety management, Waste management and disposal, Emergency care, First aid in accidents and poisoning, *Facilities* (Animal care facilities, Separation and isolation of animals, Animal supply facilities, Facilities to handle test articles and control articles, Specimen / data storage.)	6
3	*Testing facilities operation* (Documenting SOPs, Labelling reagents and solutions, Methodologies for test system handling, Quarantine, separation, isolation, and disease control, Clean cages and adequate food and water for test systems, *Conduct of nonclinical studies* (The study protocol and its uses, Correct methods of amending protocols and dealing with deviations, Correct conduct of non-clinical studies)	6
4	Theory, instrumentation and applications of Visible, UV, IR, NMR and MS spectroscopy. Simple spectroscopic problems, Circular Dichroism Spectroscopy	20
5	Chromatography (Ion exchange, Molecular Sieve, Affinity, Thin layer GC and HPLC), Radio isotope techniques: Detection and measurement of radioactivity, Geiger Muller counters, Scintillation counting, Autoradiography and RIA, Electron microscopy,	7
	Total Contact Hours	42

REFERENCE BOOKS

10. GLP Essentials: a Concise Guide to Good Laboratory Practices Milton. A. Anderson (2002)
11. Good Laboratory Practice Regulations / Edited by Sandy Weinberg 4th edition, (2007)
12. Identifications of Organic Compounds by R. M. Silverstein, John Wiley, 8th edition, 2015.
13. Practical Biochemistry, Principles and Techniques - Keith Wilson and John Walker (2009)

Evaluation Scheme:

Assessment	Max. marks	Duration	Course Covered
T1 Test	15	1 hr.	Syllabus covered upto T-1
T2 Test	25	1.5 hrs.	Syllabus covered upto T-2
End Term Test	35	2 hrs.	Entire Syllabus
Teacher Assessment	25	Entire Sem	Based on Assignments, quizzes etc.

General Microbiology lab

COURSE CODE: 18MS7BT111

COURSE CREDITS: 1
CORE/ELECTIVE: CORE
COURSE CORDINATOR: Dr. Ashok Kumar
L-T-P: 0-0-2

Pre-requisite: None

Course Objectives:

1. To gain experience in microbiological techniques used in study of microbes
2. To familiarize the students with basics of methods with experimental analysis

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO1	To familiarize the students with basic microbiology instruments in the lab and basic precautions to be taken.	Familiarity
CO2	To aware the students about basic microbiological techniques to study the microorganisms.	Assessment
CO3	Able to analyze bacterial growth kinetics (homogeneous reaction) in the laboratory	Assessment
CO4	Able to understand the basis of microbial resistance against antibiotics and growth of pathogenic organisms.	Usage
CO5	To develop a strong foundation about microbes and their applications	Usage

List of Experiments

S.No	Description	Hours
1	**Microscopy and Instrumentation** **1.** To study the construction and working of compound microscope. **2.** Study of microbiology-lab instruments. (Operation of autoclave, LAF, hot air oven, Culture room fumigation using formalin).	
2	**Staining techniques** **3.** Gram's staining and test for differentiation of bacteria. **4.** To perform acid fast staining. **5.** To perform Lacto phenol Cotton Blue slide mounts for fungal culture.	
3	**6.** Preparation and sterilization of bacterial and fungal culture media (Nutrient broth, nutrient agar slant, potato dextrose agar)	
4	7. Streaking and plating methods for isolation of axenic culture of bacteria. **8.** Isolation and enumeration of bacteria from soil, water and air using serial dilution technique	
5	**9.** Study of bacterial growth kinetics using Turbidometry, **10.** Cell count using haemocytometer. **11**. Effects of various environmental factors such as the presence or absence of oxygen, temperature and pH on growth of microbes. **12.** Physical and chemical methods used to control the growth of microbes and the growth of microbes on various selective and differential media. **13.** Filter paper disc method for evaluation of antibiotic resistant activity of bacteria. Antimicrobial Sensitivity Testing – The Kirby-Bauer Method	

6	**14.** Preparation of nutrient agar slants and glycerol stocks for preservation. **15.** Lyophilization and Glycerol stock of bacteria for long term preservation	
Total Lab hours		

Suggested/Resources:

1. **TEXT BOOKS**

1	**Introduction to Microbiology : A Case-History Study Approach by John L. Ingraham, Catherine A. Ingraham, Hardcover: 816 pages, Publisher: Brooks Cole**
2	**Microbiology : A Laboratory Manual (7th Edition) by James Cappuccino, Natalie Sherman, Paperback: 544 pages, Publisher: Benjamin Cummings**
3	Microbiology: A Laboratory Experience; Holly Ahern Creative Commons License: Attribution-NonCommercial-ShareAlike CC BY-NC-SA

2.

3. **REFERENCE BOOKS**

1	Willey, Joanne, Linda Sherwood, Chris Woolverton. Prescott's Microbiology, 8th edition. New York: McGraw Hill, 2011. Print.
2	Willey, Joanne, Linda Sherwood, Chris Woolverton. Lab Excercises in Microbiology, 8th edition. New York: McGraw Hill, 2011. Print
3	James G. Cappuccino and Natalie Sherman. Microbiology: A Laboratory Manual, 7th edition. Benjamin Cummings, 2004. Print.

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Lab Assessment	60 Marks
	Total	100 marks

Immunology and Imumunotechnology

COURSE CODE: 18MS1BT211

COURSE CREDITS: 4
CORE COURSE
L-T-P: 3-1-0

Prerequisites: Basic Biology.

Course Objective:
The objectives are to familiarize the students with

- Basics of Immunology: types of immunity, T-cells and B-cells, antigen-antibody reaction and major histocompatibility complex (MHC).

- Mechanisms of regulation of immune responses and immunological tolerance.
- Role played by immune response in: infectious diseases, autoimmunity, hypersensitivity reactions, immunodeficiency diseases and vaccines.
- Different technology driven immunological applications in disease and health.

Course Outcome:
Students would gain in-depth knowledge of basic immunology and roles played by immune system in various common diseases, and immunological applications in health and disease. Students with plans to carry out higher studies should be able to relate and apply immunological principles in their research while students inclined towards industrial career should be able to envision themselves as a part of the R &D sector in the area of immunology.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	To understand the basic concepts of immunology.	Familiarity
CO-2	To understand the functions of components of the immune system and their role in the diagnostics.	Assessment
CO-3	To understand the roles played by immune response in: infectious diseases, autoimmunity and vaccines.	Assessment
CO-4	To understand the transfer of protective immunity, assessment of immune response and production of antibodies.	Assessment/ Usage
CO-5	To understand the basics of various immunotechnological techniques and their applications.	Assessment/Usage

Course Contents:

Unit	Contents	No. of Lectures = 42
1	**Fundamental concepts:** specificity, memory, discrimination of self from non-self, innate and acquired immunity, immune organs, tissues, cells. development and developmental defects of/in immune system, humoral and cell-mediated immune response, antigen recognition by immune system: recognition of antigens by T and B Cells.	6
2	**Immunoglobins and antigens**: immunoglobins: structure and function, immunoglobin classes, antigens, Immunogenicity, antigenicity, epitopes, haptens, mitogens, antigen-antibody interactions.	3
3	**Interaction of immune system with antigen:** antigen processing and presentation, MHCs, role of MHC molecules in antigen presentation and co-stimulatory signals.	4
4	**Cytokines:** structure and function, cytokine receptors, regulation of immune response, cytokine related diseases, diagnosis and therapeutic application of cytokines.	2
5	**Immune system in diseases:** Immune response and bacterial, parasitic and viral infections, congenital and acquired immunodeficiency; tolerance and autoimmune diseases, transplantation and tumor Immunology, diagnosis and therapeutic approaches.	6

6	**Vaccines:** active immunization: subunit vaccines; recombinant DNA and protein based vaccines, peptide vaccines, conjugate vaccines; passive Immunization: antibody, transfusion of immuno-competent cells, stem cell therapy; cell based vaccines, high throughput identification of pathogen specific potential antigens for vaccine development, Immunoinformatics and vaccine design, methods for evaluation of clinical immune response to vaccines**.**	**5**
7	**Immune studies *in vivo* animal models and human subjects:** Assessment of protective immunity, transfer of protective immunity, Assessment of immune responses in humans, adoptive transfer of lymphocytes and hematopoietic stem-cell transfers	**4**
8	**Production and engineering of antibodies:** Production of monoclonal and polyclonal antibodies, hybridoma technology, specific and cross reactivity, anti-immunoglobulin antibodies, antibody engineering, abzymes, antigen-antibody interaction as a basis of precipitation and agglutination reactions, blood typing, RIA, ELISA, Imaging-Immunohistochemistry, Immunoprecipitation and co-immunoprecipitation, Immunoblotting	**6**
9	**Detection, measurement and characterization of antibodies and their use as research and diagnostic tools: Characterization and analysis of cellular and soluble immune components:** Isolation and enrichment of specific immune cells, ELISPOT, Flow-cytometer and FACS for quantitative/qualitative analysis and sorting of different immune cell subsets, Cell functional assays-lymphoproliferation, Cell cytotoxicity, mixed lymphocyte reaction, apoptosis,	**6**

Recommended Books:

1. Kindt, T.J., Goldsby, R.A. and Osborne, B.A. (2007). Kuby Immunology .W.H. Freeman and Co., New York, 7th Ed.
2. Kenneth Murphy, Charles A Janeway, Paul Travers and Mark Walport (2007) Immunobiology Garland Science, 8th Ed.
3. Abbas AK, Lichtman AH and Pillai S (2001) Cellular and Molecular Immunology; Elsevier, USA, 7th Ed.
4. Roit, I. (2012). Essential Immunology. Blackwell Scientific Publications, Oxford, 12th Ed.
5. Primrose SB, Twyman RM and Old RW (2002) Principle of gene manipulation. Wiley-Blackwell, UK, 6th Ed.
6. Chakravarty AK (2006) Immunology and Immunotechnology. Oxford University Press, 1st Ed.

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus

4.	Teaching Assessment	25	Entire Semester	Assignment, Quizzes & Attendance

BIOPROCESS TECHNOLOGY

COURSE CODE:
COURSE CREDITS: 4
CORE
L-T-P: 3-1-0

Pre-requisite: Microbiology, Biochemistry

Course Objectives:

3. Learn various bioprocess technology related terms and principles
4. Learn about microbial growth kinetics in various mode of fermentation
5. Learn about the principles and application of Sterilization and Fermentation
6. Develop an understanding of important concepts and design aspects of bioreactors and its functioning
7. Learn about the principle of scaling up and scaling down of bioprocesses
8. Learn about the principles and application of various separation techniques involved in bioproducts recovery
9. Learn about the production and recovery of various products through case studies

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Able to use correct biological terms to describe & analyze phenomena/ problems in bioprocesses	Familiarity
CO-2	Able to analyze bacterial growth kinetics (homogeneous reaction) in batch /continuous/ Fed-batch reactor and thermal death kinetics	Assessment
CO-3	Able to describe media formulation, mixing and process scale up and the related basic design calculations	Assessment
CO-4	Able to solve mathematical problems related to bioprocess phenomena including mixing, Mass transfer and sterilization	Assessment
CO-5	To develop a strong foundation about bioreactor designs and their applications	Usage
CO-6	Able to apply principles of various unit operations in designing and optimization of downstream processes	Usage

Course Contents:

S. No.	Unit	Topics Covered	Contact Hrs.
1	Introduction and Basic Concepts	Introduction to Bioprocess Technology, Isolation, screening, preservation and maintenance of industrially important microbes; Strain improvement; Fermentation economics	6
2	Cell Growth Kinetics	Cell number and Cell mass calculations, Media design for growth, Continuous, batch and fed-batch fermentation, Microbial growth kinetics, Kinetic models for cell growth, Substrate and product inhibited growth models, Factors affecting microbial growth, Cell and enzyme immobilization	7
3	Sterilization	Sterilization principles and practices; Thermal death kinetics; Media sterilization; batch and continuous sterilization; Air Sterilization	3
4	Upstream processing	Fermentation media; Media formulation; Aeration and agitation in bioprocess; Measurement and control of bioprocess parameters; Scale up and scale down process	6
5	Fermentation and Its Concepts	Types of fermentation: Solid substrate, surface and submerged fermentation; and Biotransformation; Application	3
6	Fermenter Designs	Criteria for ideal fermenter; Configuration; Bioreactor designs-mechanically agitated; Pneumatic and hydrodynamic fermenters. Whole Cell Immobilized Fermenters; Stability of microbial reactors.	4
7	Downstream processing	Introduction; Separation of insolubles: Filtration, Centrifugation, Sedimentation; Cell disruption; Liquid-liquid extraction; Precipitation; Purification by chromatographic techniques; Reverse osmosis and ultra filtration; Drying; Crystallization; Storage and packaging; Treatment of effluent and its disposal.	7
8	Case Studies	Industrial Production of Bioproducts: Ethanol, Acids (Citric, acetic, Lactic and gluconic), solvents (glycerol, acetone, butanol), Antibiotics (Penicillin, streptomycin, tetracycline), Semi-synthetic antibiotics, Amino acids (Lysine, glutamic acid), Single Cell Protein.	6
	Total Number of Lectures		**42**

Suggested Text Book(s):

1. Pauline M. Doran, “Bioprocess Engineering Principles”, 8th ed., Academic press, New York, 2003.
2. M.L. Shuler and F. Kargi, "Bioprocess Engineering--basic Concepts", 2nd Edn. Prentice-hall Of India Pvt Ltd (2008).
3. Peter F. Stanbury, Stephen J. Hall & A. Whitaker, "Principles of Fermentation Technology", Â Elsevier India Pvt Ltd. (2007).
4. Jackson AT., Bioprocess Engineering in Biotechnology, Prentice Hall, Engelwood Cliffs, 1991.

Suggested Reference (s):

1. Klaas Van’t Riet, Johannes Tramper, “Basic Bioreactor Design”, 2nd ed., Marcel Dekker, Inc., New York, 1991.
2. JE Bailey and DF Ollis, “Biochemical Engineering Fundamentals”, 2nd ed., McGraw-Hill Book Company, New York, 1986.
3. Mccabe L.Warren, Smith C. Julian and Peter Harriott, “Unit Operations of Chemical Engineering”, 6th ed., McGraw Hill International Edition, New York, 2001.
4. Comprehensive Biotechnology: The Principles, Applications and Regulations of Biotechnology in Industry, Agriculture and Medicine, Vol 1, 2, 3 and 4. Young M.M., Reed Elsevier India Private Ltd, India, 2004.

5. Mansi EMTEL, Bryle CFA. Fermentation Microbiology and Biotechnology, 2nd Edition, Taylor & Francis Ltd, UK, 2007.
6. Abhilasha S. Mathuriya, “Industrial Biochnology” 1st ed., Ane Books Pvt. Ltd., New Delhi, 2009.

Other useful resource(s):

1. NPTEL Course Content:

   i) Bioreactors by Prof. Suraish Kumar, IIT Madras
   https://nptel.ac.in/courses/102106053/
   ii) Industrial Biotechnology by Prof. Debabrata Das, IIT Kharagpur….
   https://nptel.ac.in/courses/102105058/
   iii) Aspects of Biochemical Engineering by Prof. Debabrata Das, IIT Kharagpur
   https://nptel.ac.in/courses/102105064/

2. Link to topics related to course:
   i) Mass Transfer by Prof. Bishnupada Mandal, IIT Guwahati
   https://nptel.ac.in/courses/103103034/13#

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Unit 1-2
2	T-2	25	1.5 Hours	Unit 1-6
3.	T-3	35	2 Hours	Whole Syllabus
4.	Teaching Assessment	25	Entire Semester	Inform class time to time (Quizzes, Presentation, Assignments)

Plant and Animal Biotechnology

COURSE CODE: 20MS1BT113

COURSE CREDITS: 3
ELECTIVE/CORE: CORE
L-T-P: 3-0-0
Pre-requisite: Basic Understanding of Biology

Course Objectives:

1. The objective of this course is to introduce the student to basic plant and animal cell and tissue culture techniques and their application.

2. In animal tissue culture component, the course is designed to impart an understanding pertaining to why one needs animal cell cultivation, the basic ATC set-up, the biology of cultured cells, techniques to establish and propagate cell cultures of animal origin.
3. In plant tissue culture component, the course is designed to develop an understanding about the morphology of plant cell and its utilization through different techniques of plant tissue culture for propagation, conservation and production of different plant species and their products

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Able to understand about basics of growing plant and animal cell and tissue under in vitro conditions	Familiarity
CO-2	Basic understanding of techniques and technologies used for growing plant and animal cell	Assessment & Analytical Skills
CO-3	To enable students for applying the knowledge about basic techniques of plant tissue culture for developing products.	Technical Skills
CO-4	Able to learn the methodologies for analyzing, upscaling and commercialization of plant based products.	Assessment & Analytical Skills
CO-5	To understand functional assay at cellular level, cell morphology and survival, immunolabeling in animal cells	Awareness
CO-6	To provide insight about the usage of Plant and Animal biotechnology with ethics and safety for masses and environmental utilization	Usage

Course Contents:

Units	Contents	Lectures required
1	Plant structure, growth and development Introduction, definitions and history of plant cell and tissue culture Organization of tissue culture laboratory Cellular totipotency and cell differentiation, factors affecting differentiation	3
2	Isolation of single plant cells, suspension cultures, types of suspension cultures, Measurement of the growth in suspension cultures, Assessment of Viability of the cultured cells, bioreactors used for plant cell cultures	6
3	Type of cultures and their applications: Direct and indirect methods of culture; seed culture, embryo culture, organ culture, callus culture, somaclonal variation and applications	6
4	Somatic embryogenesis Micro-propagation and its applications, Advances in acclimatization of tissue cultured plants. Haploid and triploid production and applications Protoplast isolation and fusion and application Production of virus free plants through cell and tissue culture	3
5	Secondary metabolite production and bioconversions /biotransformation through plant cell cultures and plant stem cells	3
6	Introduction to human anatomy and Physiology, An overview of different Systems, organs and tissues of human body. Basics terms and definitions, historical background, Importance of animal cell culture technology, laboratory facilities-design, equipments and safety parameters, waste disposal in a cell culture set-up. Aseptic techniques for animal cell cultivation.	7
7	Cell culture technology: Basic requirement for growing animal cells - Cell culture reagents, media, media supplements, media preparation and sterilization, Defined-Undefined media, Complete-Incomplete media, Importance of Serum and Serum free Media, culture conditions. Maintenance	7

	of cell culture: Culturing, sub-culturing, passaging.	
8	Studying biological system using cell culture techniques: Functional assays based on cell culture: Cell morphology, Quantitation, Growth pattern, Cytotoxicity assays, Study of Cell Death: senescence, apoptosis and necrosis, Cell proliferation, Cell viability measurements, FISH. Immunolabeling of cells to study molecular expression pattern–Microscopy, Flow cytometry, Immunohistochemistry, etc. Application of Cell culture Technology Hybridoma technology for monoclonal antibody production.	7
Total Lectures		**42**

Suggested Text Book(s):

1. Michael Butler, "Animal Cell Culture and Technology", BIOS Scientific Publishers
2. John R.W. Masters, " Animal Cell Culture-A Practical Approach", Oxford University Press
3. R. Ian Freshney, "Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications".
4. Introduction to Plant biotechnology H S Chawala
5. Plant tissue culture: theory and Practice S.S.Bhojwani and M K Razadan
6. Plant tissue culture S.S.Bhojwani and M K Razadan
7. Elements of Biotechnology P K Gupta
8. Plant cell and tissue culture Narayan Swamy

Suggested Reference Book(s)

1. Molecular Biology of the Cell: by Bruce Alberts, 4th Edition 2002.
2. Lodish, et al. Molecular Cell Biology. 5th ed. New York, NY: W.H. Freeman and Company, 2003.

Other useful resource(s):

1. Link to NPTEL course contents: https://nptel.ac.in/
2. https://nptel.ac.in/courses/102103012/
3. https://nptel.ac.in/courses/102104059/
4. https://nptel.ac.in/courses/102103016/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment, Quizzes & Attendance

Plant and Animal Biotechnology Lab

COURSE CODE:
COURSE CREDITS: 1
CORE/ELECTIVE: CORE

L-T-P: 0-0-2

Pre-requisite: Basic Biology

Course Objectives:

10. The objective is to familiarize students with the various plant and animal cell culture techniques.
11. To provide experience in handling plant and animal cells or tissues under in vitro conditions.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO1	To understand, design, analyze and interpret experiments related to plant and animal cell culturing	Familiarity
CO2	To understand, design, analyze and interpret experiments related to Animal cell culture and link practical knowledge to theoretical	Analytical Skills
CO3	To understand, design, analyze and interpret experiments related to Plant tissue Culture and link practical knowledge to theoretical	Analytical Skills
CO4	Able to handle and perform experiments for in vitro growth and development of plant and animal cells	Technical Skills
CO5	To understand team work, ethics and work discipline.	Use

List of Experiments

S.No	Description	Hours
1	Laboratory Safety and Introduction to ATC	2
2	Fluid Transfer using aseptic technique	2
3	Preparation of stock media and filter sterilization	2
4	Handling and Sub culturing of animals cells	2
5	Cryopreservation and Revival of Cell culture	2
6	Assessment of cytotoxicity/Biological screening of herbal/synthetic molecules	2
7	Introduction to various equipments and their working in plant tissue culture lab setup and Preparation of stocks solutions, hormones culture medium	2
8	Establishment of Callus and Suspension cultures and measuring cell growth	2
9	Plant regeneration from callus and somatic embryogenesis	2

10	Microproapagation of different plant species by axillary shooting	2
11	Hardening or Acclimatization of cultured plantlets to field conditions	2
12	Meristem culture for virus elimination. Anther and pollen culture for haploid production	2
13	Protoplast isolation and determining the protoplast viability	2
Total Lab hours		**26**

Suggested/Resources:

1. Lab Manual
2. Plant Cell and Tissue Culture - A Tool in Biotechnology: Basics and Application (Principles and Practice) by: Karl-Hermann Neumann publisher: Springer
3. Tissue Culture for Plant Propagators by R.A. de Fossard
4. Plant Culture Media, Volume 1,Formulations and Uses by E.F. George
5. Micropropagation: Technology and Application by P.C. Debergh and R.H. Zimmerman Kluwer Academic Publishers
6. Virtual Lab. (http://vlab.amrita.edu)

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Lab Assessment	60 Marks
	Total	100 marks

M. Sc. Biotechnology

Detailed Syllabus

Course Title: Immunology and Immunotechnology Lab
Course Code: 18MS7BT211

Credits:

Prerequisites: Basic Biology/ Immunology

Objective:

The objective is to familiarize students with the various immunological techniques that include antigen-antibody interactions, quantitation of antigens or antibody, ELISA, agglutination reactions etc.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO1	To understand, design, analyze and interpret experiments related to immunology and link practical knowledge to theoretical.	Familiarity
CO2	To detect antigen and check quality/quantity of antigen.	Familiarity/Assessment

CO3	To check changes in the number of leucocytes, their isolation from the blood and identify cells secreting cytokines specific to antigens.	Familiarity/Assessment
CO4	To understand team work, ethics and work discipline.	Usage

List of Experiments:

S.No.	Experiments
1	To quantify the concentration of unknown antigen by radial Immunodiffusion (RID).
2	To determine the identity of antigen by double Immunodiffusion (DID).
3	To quantify the concentration of unknown antigen by rocket Immunoelectrophoresis.
4	To characterize the given antibody by Immunoelectrophoresis.
5	To determine the presence of antigen by Dot ELISA method.
6	To check antigen- antibody reaction by performing Direct and Indirect Coombs Test.
7	To quantify the amount of precipitation by Quantitative precipitation assay.
8	To perform latex agglutination test to detect an unknown antigen.
9	To separate mononuclear cells from peripheral blood
10	Assay for cellular apoptosis/proliferation.
11	To estimate the antibody titer using haemagglutination assay.
12	To determine Total Leukocytes Count (TLC) of the given blood sample.
13	To understand and learn the basic concepts of ELISPOT Assay. To learn about the procedure and various reagents involved in performing the assay. (Virtual lab)
14	To learn how to perform fluorescent antibody labelling. To know how to calculate the amount of fluorescent dye bound to protein with a spectrophotometer. (Virtual Lab)

Reference books

1. Lab Manual
2. Hay FC and Westwood OMR (2003) Practical Immunology, 4th Ed., Blackwell Publishing.
3. Barbara Detrick, John L Schmitz and Robert G Hamilton (2016). Manual of Molecular and Clinical Laboratory Immunology.
4. V.Lab (http://vlab.amrita.edu/?sub=3&brch70

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Lab Assessment	60 Marks
	Total	100 marks

Basic Bioinformatics

COURSE CODE:
COURSE CREDITS: 4
ELECTIVE
L-T-P: 3-0-0

Pre-requisite: Molecular Biology, Biochemistry

Course Objectives:

12. Background and need for bioinformatics
13. Learn sequence analysis techniques.
14. Learn sequence alignment-pairwise and multiple.
15. Apply phylogenetic analysis.
16. Application of bioinformatics in modern day research.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Knowledge of bioinformatics databases and resources	Familiarity
CO-2	Sequence analysis including pairwise sequence alignment	Assessment
CO-3	Sequence analysis using multiple sequence alignment	Assessment
CO-4	Sequence annotation by identifying motifs, domains, conserved regions, predicting secondary structure of protein sequences	Usage
CO-5	Perform phylogenetic analysis of protein sequences and RNA secondary structure prediction	Assessment

Course Contents:

S. No.	Unit	Topics Covered	Contact Hrs.
1	**Introduction**	Bioinformatics and its role in modern biology, Next generation sequencing	3
2	**Pairwise sequence alignment techniques**	Dot plots-word size and stringency method, Alignments (Needleman & Wunsch algorithm, Smith-Waterman algorithm-with advanced scoring systems), semi-global alignment, Statistics of sequence alignment score: E-value and P-value	8
3	**Sequence Alignment**	Sequence Alignment: Dot plots, Alignments (Needleman & Wunsch algorithm, Smith-Waterman algorithm-with simple scoring systems), Multiple sequence alignment, Amino acid distance measures (PAM matrices, Blosum matrices)	8

4	**Database search**	Database searching : FASTA, BLAST	8
5	**Fundamental of sequence alignment**	Sequence similarity: Basic concepts, similarity scores	7
6	**Primer design**	Principles, Programs for Primer Design	4
7	**Distance measures**	Nucleotide distance measures (simple counts method, Jukes-Cantor correction, Kimura 2 parameter correction);	4
8	**Phylogenetic reconstruction**	Introduction, distance method (UPGMA, NJ), parsimony method	7
9	**Gene prediction**	Principles and programs for Gene prediction.	2
10	**Structural alignment of proteins**	Sequence-dependent structure superposition: RMSD, Sequence-independent structure alignment, DALI, VAST, CE, TM-Align	2
11	**Secondary structure and tertiary prediction methods**	Chou-Fasman, PHD, PSIPRED Comparative modeling, threading,	7
12	**RNA secondary structure prediction**	Principles and programs for RNA secondary structure prediction	3
	Total Number of Lectures		**42**

Suggested Text Book(s):

1. Bioinformatics: D.W. Mount
2. Introduction to Bioinformatics by Arthur Lesk
3. Bioinformatics: Databases, tools and Algorithms by Orpita Bosu and Simminder Kaur Thukral
4. Knowledge discovery in Bioinformatics: Xiaouha Hu, Yi Pan

Suggested Reference (s):

1. Sousa et al., Bioinformatics Applications in Life Sciences and Technologies, 2016. PubMed PMID: PMC4870335

Other useful resource(s):

1. https://www.hindawi.com/journals/isrn/2013/615630/
2. https://www.sciencedirect.com/science/article/pii/S0888754317300551

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2

3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment, Quizzes & Attendance

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Basic Bioinformatics Lab

COURSE CODE: 18MS7BI214

COURSE CREDITS: 1
CORE/ELECTIVE: CORE
L-T-P: 0-0-2

Pre-requisite: None

Course Objectives:

17. Understand the importance of bioinformatics
18. Application of various bioinformatics tools

19. Understand the connection of bioinformatics and biotechnology

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO1	Understand the use of various bioinformatics resources (NCBI, Expasy, Pfam)	Usage and familiarity
CO2	Understand tools in NCBI (BLAST types etc.)	Assessment
CO3	Understand various databases and tools in Expasy (Swissprot, PROSITE)	Assessment
CO4	Hands-on of pairwise sequence alignment tools-global and local	Assessment
CO5	Hands-on of multiple sequence alignment tools-global and local	Assessment
CO6	Hands-on of phylogenetic analysis tools and visualization	Assessment

List of Experiments

S.No	Description	Hours
1	NCBI-Exploration of different databases and tools	**2**
2	BLAST program in online page and standalone package	**2**
3	PubChem database, Use of Swiss-Prot, PROSITE and PFAM databases	**2**
4	Multiple sequence alignment (MSA) programs and viewers: ClustalW, Jalview in online mode	**2**
5	Use of MSA programs (ClustalW) as a standalone package	**2**
6	Use of structural databases like PDB and structure visualization using Pymol and Rasmol	**2**
7	EMBOSS, STADEN and STAMP packages for sequence analyses	**2**
8	Gene prediction methods- GENPRED, GenePred	**2**
9	Phylogenetic analysis methods and tree viewers: Phylip and Archaeopteryx	**2**

10	Use of Phylip software as standalone package, MrBayes etc.	**2**
11	KEGG and GO database	**2**
12	Homology modeling in MODELLER, Docking in PatchDock	**2**
13	Prediction of RNA secondary structure	**2**
14	Use of structural classification databases like SCOP, CATH, FSSP	**2**
Total Lab hours		**28**

Suggested/Resources:

4. Pevsner J.:Bioinformatics and Functional Genomics; Cold Spring Harbor Laboratory Press, New York.
5. Baxevanis AD & Oulette BFF: Bioinformatics – A practical guide to the Analysis of Genes and Proteins, Willey International publishers.

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Lab Assessment	60 Marks
	Total	100 marks

Environmental Biotechnology
COURSE CODE:
COURSE CREDITS: 3
COURSE COORDINATOR: Dr. Ashok Kumar
L-T-P: 3-0-0
Pre-requisite: Environmental pollution: Cause and remediation strategies
Course Objectives:

Environmental Biotechnology is a rapidly developing, increasingly important branch of science that has implications for both the prevention and cleans up of pollution in domestic and industrial waste streams. The environmental applications of biotechnology will be presented in detail and will be supported by examples from the national and international literature. Such environmental applications of biotechnology include: Bioremediation of pollutants, applications in agriculture, applications in sustainable development in various industries well as in detection and monitoring environmental deterioration.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO I	Students will become aware of concept and scope of environmental biotechnology.	Familiarity
CO II	Students will have knowledge different techniques of bioremediation of pollutants	Assessment

CO III	Students will acquire knowledge about application of biotechnological methods in agriculture to reduce environmental impact.	Assessment
CO IV	Student will have acquaintance use of bioresources and biotechnology in various industries for sustainable development	Usage
CO V	Students will have knowledge about biotechnological methods for detection and monitoring of environmental deterioration	Usage
CO VI	Can analyse case-studies representative of key areas of environmental biotechnology	Assessment

S. No.	Unit	Topics Covered	Contact Hrs.
1	**Environmental Biotechnology**	Concept, Scope, areas and examples on subject matter	2
2	**Bioremediation**	Fundamentals, Methods and strategies In situ and Ex situ bioremediation, (Bio)venting, (Bio)sparging, (Bio)stripping, (Bio)sorption barriers, Biofilters, Bioreactors, Case studies , Phytoremediation: Technical considerations, Types factors case studies	8
3	**Hazardous Waste Management**	Energy Resource Recovery from Hazardous Waste Medical waste, Electronic waste. Characterization of the Harmful Effects of Chemicals and Materials, and Fate of HM in Environment risk Assessment.	8
3	**Environmental Protection Biological waste Treatment**	: Thermochemical conversion of biomass: combustion, pyrolysis, gasification, catalysis. Composting, Vermocomposting, Incineration Landfill Recycling Windrow composting. Liquid waste treatment; Biofilters, activated sludge systems.	4
4	**Environmental Biotechnology and Agriculture**:	Bio fertilizers: Symbiotic systems between plants – microorganisms, Chemical pesticide, Biopesticides, Biological control of pests Plant growth promoting rhizobacteria (PGPR) – uses, practical aspects and problems in application Soil Enzymes – origin and range of enzymes in soil, methods of measurement and extraction of soil enzymes, interactions between agrochemical and soil enzymes.	8
5	**Renewable energy and bio-based products**	Bioconversion of biomass to fuels, liquid and gaseous biofuels production, modelling and economics, Polutry waste biomass, Bio adhesives, Biopolymers, Bio lubricants, Bio plastics, fibers and paper.	8
6	**Detection of Pollutants and Environmental Monitoring**:	Bio-Indicators or Biomarkers, Biosensors for Environmental Monitoring. Toxicity screening of samples using bioluminescence or fluorescence, Water quality monitoring, Atmospheric quality bio-monitoring, and. Soil-contamination bio-monitoring.	4
		Total Number of Lectures	**42**

TEXT BOOKS

1 **Environmental Biotechnolgy MH. Fulekar**

2 **Environmental Biotechnology (By: Arvind Kumar)**

3 **Textbook of Environmental Biotechnology P.K. Mahapatra**

4. **Introduction To Environmental Biotechnology 3rd Edition (English, Paperback, A. K. Chatterji)**

REFERENCE BOOKS

1 **Environmental Biotechnology: Theory and Application Gareth M. Evans (Author), Judith C. Furlong (Author)**

2 **Environmental Biotechnology" by Bhattacharya B C and Banerjee R**

Other useful resource(s):

https://nptel.ac.in/course.php?disciplineId=102

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment, Quizzes & Attendance

Food Biotechnology

COURSE CODE: 18MS1BT311

COURSE CREDITS: 3
CORE
L-T-P: 3-0-0

Pre-requisite: Basic Biology, Introduction to Biochemistry and microbiology

Course Objectives:

1. To understand the concept of food science, technology and safety issues.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Basic understanding of food chemistry and nutrition	Familiarity
CO-2	Able to understand the concept of biotechnology in food science	Assessment
CO-3	Able to apply technology in Processing of food products	Assessment
CO-4	Able to understand the safety issues and emerging technologies in food science	Usage

Course Contents:

S. No.	Topics Covered	Contact Hrs.
1	**Food Components and their role in nutrition:** Carbohydrates, Proteins, fats, anti-nutrients, phytochemicals,	3
2	**Food Quality and hazards:** Perception, organoleptics and relation of nutrition to health, Food hazards: Physical, chemical, microbial (parasitic and viral) and engineered hazards: their threats; methods for detection and documentation.	4
3	**Food fermentation** Nutritional value of fermented food, requirements of fermentation, Benefit of fermentation - nutritive value of fermented food, various substrate used in fermentation and different types of fermentation.	4
4	**Starter culture Technology** Definition, types, propagation of starter cultures, Quality and activity of starter , factors affecting quality of starters, defects, Preservation of starter cultures.	4
5	**Microorganisms in fermented foods** LAB-taxonomy, role in preservation, and basic metabolism, LAB metabolism of carbohydrate and protein, Molds and Yeasts in food fermentation, Microbial changes in fermented foods.	4
6	**Fermented Foods**: Sauerkraut, soy based fermented products,	3
7	**Fermented dairy products** Cultured milk, yoghurt, cheese production and other fermented milk products,	3
8	**Bread fermentation** Baker's yeast importance in bread fermentation, production technology of baker's yeast,	3
9	**Alcoholic beverages** Production of beer, wine and vinegar,	4
10	**Traditional fermented foods** Idli, dosa and other traditional fermented foods.	3
11	**Food safety issues of new biotechnologies** HACCP, GMP, GAP, SPS, TQM, Six sigma, EIA and ISO. Food designing and processes: Advanced and conventional processing and preservation methods Food	4

	packaging and labelling (Nutritional claim and health claim),	
12	**Emerging Technologies used in functional food** Food vehicles, Targeted delivery, Microencapslation and Nanotechnologies, Nutraceuticals	3
	Total Number of Lectures	**42**

Suggested Text Book(s):

1. Biochemistry Stryer 7thEdition Biochemistry by Berg JM, Tymoczko JL, and Stryer L, published by W.H. Freeman and Company
2. Microbiology 5th edition E.C.S. Chan, Michael J. Pelczar, Jr., Noel R. Krieg
3. Prescott's microbiology Willey, J. M., Sherwood, L., Woolverton, C. J., Prescott, L. M., and Willey, J. M. (2011). New York, McGraw-Hill.
4. Microbiology: An Introduction 12thEdition Gerard J. Tortora, Berdell R. Funke and Christine L. Case
5. Principles of Fermentation Technology 3rd Edition Peter Stanbury Allan Whitaker Stephen Hall
6. Fundamentals of Food Biotechnology Byong H. Lee John Wiley and Sons
7. Food Microbiology M. R. Adams and M. O. Moss
8. Basic Food Microbiology George J. Banwart
9. Fundamental Dairy Microbiology Prajapati, J.B.
10. Lehninger Principles of Biochemistry, 5thEdition David L. Nelson and Michael M Cox.

Other useful resource(s):

https://onlinecourses.nptel.ac.in/noc18_ar10/preview

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment, Quizzes & Attendance

Food Biotechnology Lab

COURSE CODE: 18MS7BT311

COURSE CREDITS: 1
CORE/ELECTIVE: CORE
L-T-P: 0-0-2

Pre-requisite: Basic Biology, Introduction to Biochemistry and microbiology

Course Objectives:

20. The objective is to familiarize students with the technologies and processes in Food Science.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO1	To understand, design, analyze and interpret experiments related to food science and link practical knowledge to theoretical.	Technical & Analytical Skill
CO2	To understand, design, analyze and interpret experiments related to food microbes and fermented food products	Technical & Analytical Skill
CO3	To understand, design, analyze and interpret experiments related to quality and nutritional value of food commodities	Technical & Analytical Skill
CO4	To understand team work, ethics and work discipline.	Usage

List of Experiments

S.No	Description	Hours
1	Introduction to Food Science and Laboratory Safety	2
2	Isolation of food spoilage microorganisms	2
3	Studies on metabolic activities of starter cultures	2
4	Production of fermented dairy product (Curd)	2
5	Production of Mozzarella cheese using acidification method	2
6	Production of fermented beverages (wine)	2
7	Fermenting power of yeast	2
8	Estimation of saponification value	2
9	Determination of acidity of water	2
10	Determination of alkalinity/ hardness of water	2
11	Determination of gelatinization temperature range of different starches and effect of additives	2

12	Determination of proteins in food commodities	2
13	Determination of fats in food commodities	2
Total Lab hours		**26**

Suggested/Resources:

1. **Laboratory Manual of Food Microbiology** Neelima Garg, K L Garg and K.G. Mukerji
2. **Protein measurementwith the Folin phenol reagent** Lowry, O.H., Rosebrough, N.J., Farr, A.L., and Randall, R.J. (1951) J.Biol.Chem 193: 265.
3. **Standard Methods for the Examination of Water and Wastewater** AWWA, WEF, APHA, 1998,(Methods: 4500 B. Electrometric Method; 2320 B. Titration Method)
4. **Chemistry for Environmental Engineering4th Edition** Sawyer, C.N., McCarty, P.L., and Parkin, G.F. 2000, Tata McGraw-Hill Publishing Company Limited.
5. **Measurement of the gassing power of Bakers' Yeast:Correlation between the dough volume and the incubationtime** Walter Borzani, Vol.47, pp. 213-217
6. **An Introduction to Practical Biochemistry, 3rd edition** David T Plummer, McGraw-Hill, c. McGraw-Hill Book Company (U.K.) Ltd.,London. 1987.
7. **"Experimental Biochemistry"** Beedusashidharrao, Vijay Deshpande, I K International Pvt.ltd; ISBN 81-88237-41-8.
8. **Laboratory Manual in Biochemistry** Jayaraman J; Wiley Eastern Limited. 2.
9. **Test Method for Acidity, Saponification value, Ester value, Iodine value and Hydroxy value of Chemical products and Unsaponifiables.** JIS K 0070-1992
10. **Determination of Fat** United States Department of Agriculture Food Safety and Inspection Service, Office of Public Health Science
11. **The Anthrone Method for the Determination of Carbohydrates in Foods and in Oral Rinsing** Thomas G. Ludwig and Hyman J.V. Goldberg1956
12. **Manufacture cheese of mozzarella by direct acidification withreduced amounts of rennet and pepsin 1** R. Mickettsand N. F. Olson
13. **Manual of methods of analysis of foods** Food safety and standards authority of India, Ministry of Health and Family Welfare Government of India,New Delhi,2015

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Lab Assessment	60 Marks
	Total	100 marks

ENZYMOLOGY AND ENZYME TECHNOLOGY

COURSE CODE: 18MS1BT312

COURSE CREDITS: 3
CORE
L-T-P: 3-0-0
Pre-requisite: Biochemistry

Course Objectives:

21. Learn about basic aspects of enzymes and their function and structure
22. Learn about mechanisms of various enzyme catalyzed reactions
23. Learn about the important aspects of enzyme kinetics

24. Learn about the regulatory mechanism of enzymes
25. Learn about the potential applications of enzymes

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Able to understand basic concepts of enzymes	Familiarity
CO-2	Able to understand the mechanism of action in various enzyme catalyzed reactions	Assessment
CO-3	Able to understand kinetics of enzymes	Assessment
CO-4	Able to solve mathematical problems related to enzyme kinetics and inhibition	Assessment
CO-5	Able to understand about various regulatory mechanism of enzymes	Assessment
CO-6	Able to understand the present potential of enzyme in industrial and clinical application and improved activity of the enzyme using various molecular biology techniques.	Usage

Course Contents:

S. No.	Unit	Topics Covered	Contact Hrs.
1	**Introduction to Enzymes**	Basic concepts, classification of enzymes, Unit of activity, Criteria of purity of enzymes- Specific activity, Role of coenzymes. Protein and non-protein enzymes: Isozyme, Synzyme, Abzymes, Ribozymes and DNAzymes, Metallozymes, Metal activated enzymes, Coenzymes and Cofactors, Prosthetic group,	8
2	**Characteristics of enzymes and their reactions**	Enzyme structure hierarchy: Primary, Secondary, tertiary and quaternary. Active sites and allosteric sites. Nature of active site, identification of functional groups at active site, enzyme-substrate complex. Enzymes Specificity, Types of specificity	6
3	**Enzyme Catalysis**	Hypothesis of enzymatic reactions, lock and key hypothesis induced fit hypothesis, Mechanism of enzyme action: acid-base catalysis, covalent catalysis, metal ion catalysis, proximity and orientation effects, nucleophilic and electrophilic catalysis. Mechanism: Chymotrypsin, Lysozyme, Carboxypeptidase A, Ribonuclase, Zymogens.	8
4	**Enzyme Kinetics**	Kinetics of Enzyme Catalysed Reactions: Michaelis-Menten hypothesis, transformations of Michaelis-Menten equation and determination of Km & V_{max}, substrate inhibition and activation, multireactant enzymes, King and Altman method of deriving steady-state velocity equations, Kinetics of Enzyme inhibition, Kinetics of Allosteric enzymes	8
5	**Regulation of Enzyme Activity**	Brief account of enzyme induction and repression, Feedback Regulation, Allosteric regulation, covalent modification, Proteolytic activation, Effect of temperature and pH on rate of enzyme catalysed reaction. Mechanism of enzyme degradation. Application of enzymes in various synthetic reactions	7
6	**Industrial and clinical applications of enzymes**	Industrial Enzymes: Thermophilic enzymes, amylases, lipases, proteolytic enzymes. Cellulose degdrading enzymes, Enzymes in food, leather, meat industries. Clinical enzymes: Enzymes as thrombolytic agents, anti-inflamatory agents, Streptokinase, Asparaginase, Transaminases, Cholinesterases, Phosphatases, ELISA, Biosensors. Enzyme engineering.	5
	Total Number of Lectures		**42**

Suggested Text Book(s):

1. Devasena, T., "Enzymology", 1st ed., Oxford University Press, 2010.
2. Berg, J.M., Tymoczko, J.L. and Stryer, L., "*Biochemistry*", 5th ed., W.H. Freeman and Company, New York, 2002
3. Nelson D.L., Cox M.M., "Lehninger Principles of Biochemistry", 5th ed., W.H. Freeman and Company, New York, 2008.

Suggested Reference (s):

7. Pye, E.K. and Wingard, L.B., "*Enzyme Engineering II*", Plenum Press, 1974.
8. Illanes A, "Enzyme Biocatalysis", Springer Science, 2008.

Other useful resource(s):

2. NPTEL Course Content:

iv) Enzyme Science and Engineering by Prof. Subhash Chand, IIT Delhi
https://nptel.ac.in/courses/102102033/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Unit 1-2
2	T-2	25	1.5 Hours	Unit 1-4
3.	T-3	35	2 Hours	Whole Syllabus
4.	Teaching Assessment	25	Entire Semester	Inform class time to time (Quizzes, Presentation, Assignments)

ENZYMOLOGY AND ENZYME TECHNOLOGY LAB

COURSE CODE: 18MS7BT312

COURSE CREDITS: 1
CORE/ELECTIVE: CORE
L-T-P: 0-0-2
Pre-requisite: Biochemistry Lab
Course Objectives:

26. Provide exposure to the students with hands on experience on various practices in Enzymology and Enzyme Technology.
27. Enable students to link the theoretical knowledge of Enzymology and Enzyme Technology with the experiments.
28. Enable to Learn how to carry out enzyme assays
29. Learn how to determine various Michaelis Menten's Kinetics parameter
30. Learn how to characterize an purified enzyme practically
31. Learn about the influence of various physicochemical characteristics upon enzyme activity

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Able to apply practical knowledge to understand the various important aspects of enzymes usage in biotechnology industries	Familiarity
CO-2	Able to design experiments and to analyze various data related to various practices in enzymology and enzyme technology and its interpretation and their documentation	Assessment
CO-3	Able to understand and determine various kinetics parameters of an enzyme	Usage
CO-4	Able to plot graphs and its interpretation	Assessment and Usage
CO-5	Able to perform immobilization of enzyme	Assessment and Usage
CO-6	Able to work in a team to accomplish the experiments	Assessment

	and to document the experiments properly in lab note books	

List of Experiments

S. No.	Description	Hours
1	Introduction of Lab and lab safety	**2**
2	Determination of enzyme activity and specific activity of purified amylase enzyme	**2**
3	To analyze the effect of temperature on the enzyme activity	**2**
4	To analyze the effect of pH on the enzyme activity	**2**
5	To analyze the effect of metal ions on enzyme activity	**2**
6	To determine the thermostablity of the given enzyme	**2**
7	To determine the energy of activation of amylase enzyme	**2**
8	To determine Michaelis Menten's kinetics parameters of amylase enzyme	**2**
9	Determination of molecular weight using SDS-PAGE	**2**
10	Fractionation of enzyme by using ammonium sulphate precipitation	**2**
11	Preparation of Immobilized enzymes using calcium alginate beads and its characterization in term of activity and stability	**4**
Total Lab hours		**24**

Suggested/Resources:

6. Devasena, T., "Enzymology", 1st ed., Oxford University Press, 2010.
7. Lab Manual
8. Berg, J.M., Tymoczko, J.L. and Stryer, L., "*Biochemistry*", 5th ed., W.H. Freeman and Company, New York, 2002
9. Nelson D.L., Cox M.M., "Lehninger Principles of Biochemistry", 5th ed., W.H. Freeman and Company, New York, 2008.
10. Nicholas C. Price and Lewis Stevens, "Fundamental of Enzymology", Oxford University Press, Oxford. ISBN: 9780198502296.
11. Sawney S.K., Singh R. "Introductory Practical Biochemistry", Narosa Publisher, 2000. ISBN 9788173193026.

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Lab Assessment	60 Marks
	Total	100 marks

Recombinant DNA Technology

COURSE CODE: 18MS1BT313

COURSE CREDITS: 3
CORE/ELECTIVE: CORE

L-T-P: 3-1-0

Pre-requisite: Genetics, Molecular Biology

Course Objectives:

32. Familiarize the students with the basic concepts in recombinant DNA technology
33. Acquaint the students to versatile tools and techniques employed in genetic engineering and recombinant DNA technology
34. Apprise students about applications recombinant DNA technology and genetic engineering

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Students will become aware of concept of recombinant DNA technology and genetic engineering and its applications	Familiarity and Basics
CO-2	Students will have knowledge of tools and strategies used in recombinant DNA technology	Technical and strategies
CO-3	Student will acquire knowledge about gene libraries and isolation of genes, DNA and genome sequencing technologies	Technical and application
CO-4	Student will have acquaintance about protein expression hosts and genetic manipulation of plants and animals	Familiarity and Basics
CO-5	Understand application of recombinant DNA technology and genetic engineering in problem solving in academic and industrial perspective	Application

Course Contents:

Unit	Contents	Lectures required
1	**Introduction:** Genetic engineering, Recombinant DNA technology: gene cloning - concept and basic steps - rDNA Glossary	2
2	**DNA modifying enzymes and cloning techniques:** Restriction Endonucleases, DNA Ligation Enzymes and, DNA, Gene cloning methods and strategies: Cloning of PCR products, TA and TOPO TA cloning, Gateway cloning, DNA Modifying Enzymes: Nucleases, Kinases, phosphatases, Reverse transcriptase, RFLP and AFLP	8
3	**Cloning and Expression Vectors:** Plasmid Vectors, Vectors based on Lambda Bacteriophage, Cosmids, M13 Vectors, Vectors for Cloning Large DNA Molecules, Expression Vectors, Transcriptional & Translational Fusions, Adding Tags and Signals overproducing Proteins.	10
4	**Construction & Screening of genomic libraries:** Genomic library, cDNA library, Growing & Storing Libraries, cDNA Cloning (5'&3' RACE)	5
5	**Identification and isolation of genes:** Screening Libraries with Gene Probes, Screening Expression Libraries with Antibodies, Susbtacrtive hybridization, DDRT-PCR, Positional Gene Cloning, Functional Complementation	4

6	**DNA and Genome Sequencing:** Basics of DNA Sequencing, Next generation sequencing technologies, Whole genome sequencing	**6**
7	**Gene Expression in Microbial and Eukaryotic Systems:** Microbial, Yeast *Saccharomyces Cerevisiae* and Other Fungi as heterologoues protein expression platforms	**3**
8	**Genetic Manipulation of Plants and Animals:** Gene transfer methods, Application of Genetically Engineered Strains of Plants and Animals	**4**
Total lectures		**42**

Suggested Text Book(s):

1. Principles of Gene Manipulation and Genomics SEVENTH EDITION S.B. Primrose and R.M. Twyman.
2. Recombinant DNA: A Short Course by JD Watson, J. Tooze and DT Kurtz.
3. Genetic Engineering : Amita Rastogi and Neelam Pathak

Suggested Reference Book(s):

1. From Genes to Genomes: Concepts and Applications of DNA Technology by JW Dale and M Schantz
2. Molecular Biotechnology: Principles & Applications of Recombinant DNA Glick BR and Pasternak JJ
3. Genetic Engineering : Amita Rastogi and Neelam Pathak

Other useful resource(s):

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment, Quizzes & Attendance

Recombinant DNA Technology Lab

COURSE CODE: 18MS7BT373

COURSE CREDITS: 1
CORE/ELECTIVE: CORE
L-T-P: 0-0-2

Pre-requisite: None

Course Objectives:

The objective of the course is to give practical exposure to student about basic tools and techniques employed in recombinant DNA technology and genetic engineering.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO1	Students will be able to isolate and analyze plasmid vectors.	Technical
CO2	Students will be cut and ligate DNA fragments/vectors with help of restriction enzymes and ligase.	Technical
CO3	The students will be able to prepare competent cells and demonstrate bacterial transformation with given vectors	Technical
CO4	The students will be able to amplify specific DNA fragment and cloning it in T vectors demonstrate bacterial transformation.	Technical
CO5	Student will acquire proficiency in designing and conducting experiments involving genetic manipulation.	Strategies and Application

List of Experiments

S.No	Description	Hours
Lab-I	Introduction to rDNA laboratory, w.r.t. working bench, types of instruments and their handling, lab. Preparation of stock solutions of buffers for use in gel running, gel loading, their autoclaving; preparation of working buffers, antibiotic stocks, and storage of buffers required in rDNA practicals with detailed methodology. (Theory and Virtual)	**4**
Lab 2-3	Plasmid DNA Preparation: Preparation of LB medium with and without antibiotics for the growth of bacterial cultures, Growth of *E. coli*, Isolation of Plasmid DNA, Electrtrophoresis of Plasmid DNA and Interpretation of results	**4**
Lab 4	Restriction of given plasmid or λ DNA with the restriction enzyme *Eco*RI and HindIII or any other Restriction Enzymes,	**4**
Lab 4 -5	To perform ligation of λ/*Eco*R I digest using T4 DNA Ligase Electrophoresis of the uncut and digested DNA and Interpretation of the results Electrophoresis of ligated samples by agarose gel electrophoresis, Interpretation of the results	**4**
Lab 6	Setting up a PCR reaction to amplify a gene or a DNA fragment using gene specific primers	**2**
Lab 7	Preparation of competent cells of *E. coli* transformation	**4**
Lab 8	To insert the PCR product into T vector by TA-cloning, and confirmation	**4**
Lab 9-10	Transformation of E.coli. DH5 α cells with Empty puc/ pcambia1301/and Confirmation of transformed cells by scoring the expression of LacZ gene.	**4**
Lab 10-11	Transformation of E.coli. DH5 α cells with Recombinant T- vector/puc vector Confirmation of transformed cells by scoring the expression of LacZ gene.	**4**

Lab 12-13	RNA isolation and to synthesize cDNA from total RNA preparation using reverse transcriptase and oligod T primer (Virtual)	**2**
Lab 12-14	Mini Project for lab evaluation and Exam	**4**
Total Lab hours Total Contact Hours (Students are required to devote some extra time for some experiments		

Suggested/Resources:

1. Lab Manual
2. Molecular Cloning: A Laboratory Manual 2nd Edition Cold Spring Harbour Laboratory Press
3. Virtual Lab

cost estimate and construction schedule. There will be one mid term evaluation, a presentation at the end followed by a viva-voce examination

Construction Contracts and Laws: Basics of the legal system including contracts, torts, land zoning and property ownership, bonds and insurance, bidding, subcontracting, contractor liability, mechanics liens, litigation and arbitration, Indian and international construction law, hazardous waste issues and labor laws, disputes and disputes resolutions, case studies, Indian contract act, elements, types, features-suitability-design of contract documents, international contract document, law of torts; tenders: prequalification-bidding-accepting-evaluation of tender, formation and interpretation, potential contractual problems, world bank procedures and guidelines; BOT projects, arbitration, comparison of actions and laws, agreements, conditions of arbitrations, powers and duties of arbitrator, rules of evidence, Dispute Redressal Boards(DRB), Laws: legal requirements, insurance and bonding, laws governing sale, purchase and use of urban and rural land, land revenue codes, tax laws, income tax, sales tax, excise and customs duties, legal requirements for planning, property law, agency law, local government laws for approval, statutory regulations

Heavy/Civil Construction Equipment, Methods, and Management: Planning and executing heavy/civil construction projects, earthwork quantities; fundamental concepts of equipment economics; earthmoving equipment, operations, productivity, and capabilities; compaction and stabilization equipment; rock blasting and drilling equipment; asphalt mix production and placement; hoisting equipment; piles and pile driving equipment; equipment safety; optimizing crew and equipment; heavy equipment costs

Construction Cost Analysis: Cost-Benefit analysis, economic performance analysis-incremental analysis, economic feasibility analysis; advanced conceptual estimating techniques, quick methods of determining approximate costs of a project, life cycle cost analysis- technique of economic evaluation that sums the costs of initial investments, replacements, operations, maintenance and repair investments, case studies

Construction Financial Management: Introduction, modern financing theory, real estate development & finance, construction accounting systems, analysis of financial statements, managing costs, determining labor burden, managing general overhead costs, setting profit margins for bidding, profit center analysis, cash flows for construction projects & construction companies, time value of money, risks & uncertainties and management decision in capital budgeting, taxation and inflation, financing a company's financial needs, tools for making financial decisions, interest factors, amortization schedule, computerized accounting systems, international financial management, practical problems & case studies

Sustainable Design and Construction: Sustainability, challenges in sustainable construction, design construction and equipment, materials and systems, maintenance and conservation, waste materials, site waste management, re-use and recycling of materials, Energy efficient buildings, concepts of green and sustainable buildings, natural lighting, rainwater harvesting, solar panels and solar HVAC systems, sustainable building design, rating system, delivery of green buildings

Construction Capstone Project: Student will be assigned a proposed construction project, such as, commercial, educational, high rise residential, highway, bridges or industrial nature. Student will be required to complete site, geological and economic feasibility studies including city building bye laws and rules. They will develop a conceptual design and

INDIAN CONSTITUTION

COURSE CODE: 18B11HS711

COURSE CREDITS: NP

CORE/ELECTIVE: AUDIT L-T-P: 1-0-0

Pre-requisite: None

Course Objectives:

1. The course will present you about the way Indian political system has been working and the way it shapes institutions India.
2. This course is not about legal provisions and technical details of in Indian constitution. It is about how institutions are shaped through interaction with actual politics.
3. The course will introduce you to the idea of political system and the account of the making and working of constitutional institutions.
4. This course responds to the curiosity about why a particular arrangement in the constitution was adopted and why not some other, how the institutions grow in the company of actual politics.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	The present course Indian Political System: Institutional and Political Dynamics is to present a systematic analysis of all the major dimensions of Indian Political System. What better way can there be to get introduced to political system than through the politics of country? That is what the course does.	Familiarity
CO-2	The study of the Indian political system is a window to understanding politics in society.	Assessment
CO-3	The course will present about the way Indian political system has been working and the way it shapes institutions India. .	Assessment
CO-4	This course is not about legal provisions and technical details of Indian constitution, it is about how institutions are shaped through interaction with actual politics.	Usage

Course Contents:

Unit	Contents	Lectures required
1	**Introduction of the constitution:** Preamble, Salient features **Fundaments Rights and Fundamental duties:** Explanation, features and significance. Constitutional provisions and political dynamics: Judicial interpretations and socio-political realities; Fundamental Duties. **Directive principles of state policy**	3
2	**Parliament:** The Legislature: Features of parliamentary government, Merits of parliamentary government, Demerits of parliamentary government. Powers and functions of the Lok Sabha & Rajya Sabha; Parliamentary Committees; Functioning of the Parliamentary System in India.	2
3	**The Union Executive:** President, Prime Minister and Council of Ministers Constitutional Provisions/framework and political trends.	3
4	**The Judiciary:** The Supreme Court, High Court and Subordinate Courts; Judicial Review, Judicial Activism, Public Interest Litigation; Judicial Reforms	3
5	**The State Executive:** Governor, Chief Minister and The Council of Ministers; Constitutional Provisions and Political Trends. Constitutional Provisions and Political Trends.	2
6	**Panchayati Raj:** Evolution of the Panchayati Raj, 73rd amendment Act of 1992 and Provisions.	1
Total lectures		**14**

Approved in Academic Council held on 25.10.2018

Suggested Text Book(s):

1. Indian Government and politics, Abbas/ kumar Alam:Longman Kenneth A. Berman, Jerome L. Paul: Algorithms, Cengage Learning, 2002.
2. Indian Polity, Laxmikanth :McGraw Hill Education
3. Indian Politics in comparative perspective, Pravin kumar : Pearson

Suggested Reference Book(s):

1. Introduction to the Constitution of India, Brij Kishore Sharma,PHI Learning,2017

Other useful resource(s):

1. https://www.india.gov.in/my-government/constitution-india
2. https://www.india.gov.in/my-government/constitution-india/constitution-india-full-text
3. http://www.constitution.org/cons/india/const.html
4. http://www.suramya.com/india/india_constitution.php

Intelligent Control Systems

COURSE CODE: 18B1WEC632

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Fundamentals of Control Systems

Course Objectives:

1. To explain the basic disciplines of artificial intelligence, and show the possibilities of their application in control systems, for creation of intelligent control systems.
2. To study the control-theoretic foundations such as stability and robustness analysis in the framework of intelligent control.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Obtain a basic understanding of artificial intelligence techniques and know how these techniques are applied to engineering problems	Familiarity
CO-2	Select appropriately from a range of techniques when implementing control systems.	Assessment
CO-3	Know control-theoretic foundations such as stability and robustness in the frame work of intelligent systems and control.	Assessment
CO-4	Design and develop control system using artificial intelligence techniques and exposure to many real world control problems	Usage

Course Contents:

Unit	Contents	Lectures required
1	Introduction to Intelligent Control Systems: Machine intelligence, Sensors, Actuators, Controllers, External I/O devices, Applications	4
2	Computational Intelligence Techniques Applied to Control Systems Design I: Artificial neural networks, Back-propagation networks, Radial basis function networks, and recurrent networks	8
3	Computational Intelligence Techniques Applied to Control Systems Design II: Fuzzy logic, Knowledge representation and inference mechanism, Fuzzy neural networks, Deep neural networks, Optimization techniques	8
4	Typical and Special Fuzzy Controllers: Fuzzy and expert control, Parametric optimization of fuzzy logic controller, System identification using neural and fuzzy neural networks	6
5	System Stability and Robustness Analysis: Lyapunov's stability theory and Passivity Theory	4
6	Adaptive Control: Direct and Indirect adaptive control, and Self-tuning Pill Controllers	6
7	Applications to Engineering Problems: Robot manipulator control, Flight control, Under-actuated systems control, Creation of a Neural Networks with MATLAB Neural Network Toolbox	6
Total lectures		42

Suggested Text Book(s):

1. Kevin M. Passino and Stephen Yurkovich, Fuzzy Control, Addison Wesley Longman, Menlo Park, CA, 1998.
2. J.-S. R. Jang, C.-T. Sun, and E. Mizutani, "Neuro-Fuzzy and Soft Computing", Pearson, 1997.

Suggested Reference Book(s):

1. Panos J. Antsaklis, Kevin M. Passino, eds., "An Introduction to Intelligent and Autonomous Control", Kluwer

Academic Publishers, Norwell, MA, 1993.
2. T. Nanayakkara, F. Sahin, and M. Jamshidi, Intelligent Control Systems with an Introduction to Systems of Systems, CRC Press, 2008.
3. A. E. Ruano, "Intelligent Control Systems using Computational Intelligence Techniques", IET, 2005.

Other useful resource(s):

1. Link to NPTEL course contents: https://nptel.ac.in/courses/108104049/
2. Link to COURSERA course contents: https://www.coursera.org/learn/neural-networks-deep-learning/home/welcome

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignments (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Intelligent Control Systems)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	3	3	3	2	1	1	1	2	2	2	2.2
CO-2	2	3	3	3	2	2	1	1	2	1	1	2	2
CO-3	2	2	2	3	2	2	1	1	1	2	1	3	1.8
CO-4	2	2	3	3	2	1	1	2	2	2	2	2	2
CO-5	2	2	3	3	3	2	1	1	2	1	1	2	2
Average	2.2	2.4	2.8	3	2.4	1.8	1	1.2	1.6	5	2.2	2.4	

Optical Communication Systems

COURSE CODE: 18B1WEC633

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Communication Systems

Course Objectives:

1. To understand the constituents of the fiber optics communication system and optoelectronics.
2. To have an in depth knowledge of practically used optical communication systems

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Understand basics of optical communication systems.	Familiarity
CO-2	The principles that govern optical communication systems.	Familiarity
CO-3	Behavior of light as electromagnetic waves in different types of fibers.	Assessment
CO-4	The hardware components required to implement optical communication systems.	Assessment
CO-5	To efficiently design an optical communication system for practical purpose.	Usage
CO-6	The practical techniques involved in optical communication systems.	Usage

Course Contents:

Unit	Contents	Lectures required
1	Introduction: Fiber optics and Optoelectronics, Historical developments, Fiber optic communication system, Advantages, Emergence as a key technology, Role of Fiber optics technology.	5
2	Ray Propagation in Optical Fibers: Review of fundamental laws of optics, Ray propagation in Step-index and Graded-index Fibers, Effect of material dispersion, The combined effect of multipath and material dispersion, Calculation of rms pulse width.	8
3	Wave propagation in Waveguides: Maxwell's equations, Solution in a inhomogeneous medium, Planar optical waveguide, TE modes of a symmetric step-index planar waveguide, Power distribution and confinement factor, Modal analysis of an ideal SI optical fiber.	8
4	Single-mode Fibers and Multimode Fibers: Single-mode fibers, Characteristics parameters of SMFs, Dispersion in SMFs, Attenuation in SMFs, Graded-index fibers, Limitations of multimode fibers.	7
5	Optoelectronic Sources and Detectors: Fundamental aspects of semiconductor physics, the p-n junction, Current densities and injection efficiency, The basic principle of optoelectronic detection. Types of photodiodes, Photoconducting detectors, Noise considerations.	8
6	Optoelectronic Modulators and Amplifiers: Review of basic principles, Electro-optic modulators, Semiconductor optical amplifiers.	6
Total lectures		42

Suggested Text Book(s):

1. Optical Fiber Communications, John M Senior, 3rd Edition, PHI, 2009.
2. Fiber Optic Communication Systems, Govind P. Agarwal, 4th Edition, Wiley, 2010.
3. Fiber Optics and Optoelectronics, R.P. Khare Oxford University Press, 2015

Suggested Reference Book(s):

1. Fiber Optic Communications, S. Kumar and M. J. Deen, Wiley, 2014.
2. Optical Fiber Communications, G. Keiser, 5th Edition, Tata McGraw Hill, 2009.

Other useful resource(s):

1. Link to NPTEL course contents: https://nptel.ac.in/courses/117101002/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Optical Communication Systems)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	1.75
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	2
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	1.75
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	2.08
CO-5	2	3	3	3	2	1	1	1	2	3	2	2	2.08
CO-6	2	3	3	3	2	1	1	1	2	3	2	2	2.08
Average	2	2.66	2.66	2.66	2.66	1	1	1	2	2.5	1.66	2	

Microwave Theory and Techniques

COURSE CODE: 18B1WEC746

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Basics of Electromagnetic Engineering

Course Objectives:

1. To learn the basic principles of microwave generators and amplifiers.
2. To have foundations on microwave design principles and measurement.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	To identify different microwave components and their applications.	Familiarity
CO-2	To study the performance of specialized microwave tubes such as klystrons.	Familiarity
CO-3	To understand the principle of operation of magnetrons, traveling wave tubes and BWOs.	Assessment
CO-4	To understand the working principle of microwave solid state devices and their applications.	Assessment
CO-5	To design of microwave filters, amplifiers and oscillators.	Usage
CO-6	To learn about microwave power, VSWR, impedance and attenuation measurements.	Usage

Course Contents:

Unit	Contents	Lectures required
1	Introduction: Introduction to microwaves, Scattering matrix of microwave waveguide junction, properties of S-matrix, E-plane tee, H-plane tee, magic tee, attenuators, directional couplers, ferrite devices, Faraday rotation, gyrator, isolator, circulators and cavity resonators.	8
2	Microwave Tubes: Limitations and losses of conventional tubes at microwave frequencies, microwave tubes-O-type and M-type classifications. O-type tubes: Two cavity klystron-structure, reentrant cavities, velocity modulation process and apple gate diagram, bunching process and small signal theory- expression for output power and efficiency. Reflex Klystron-Structure, velocity modulation and apple gate diagram, mathematical theory of bunching, power output, efficiency, oscillating modes and output characteristics.	9
3	Microwave Crossed-Filed Tubes: M-Type tubes: Introduction, cross filed effects, magnetrons-different types, cylindrical travelling wave magnetron-Hull cut-off and Hartree conditions, mode of resonance and PI-mode of operations, separation of PI-mode, output characteristics, Backward wave crossed field oscillator (Carcinotron).	6
4	Helix TWTs: Significance, types and characteristics of slow wave structures, structure of TWT and amplification process (qualitative treatment), suppression of oscillations, gain considerations.	5
5	Microwave Solid state Devices: Introduction, classification, applications. TEDs-Introduction, Gunn diodes-principle, RWH theory, characteristics, modes of operations, IMPATT diode, TRAPATT Diode, BARITT diode, PIN diode, Tunnel diode.	7
6	Microwave Design Principles and Measurements: Microwave Filter Design, Microwave Amplifier Design, Low Noise Amplifier Design, Microwave Oscillator Design, VSWR and impedance measurement, attenuation measurement and power measurement.	7
Total lectures		42

Suggested Text Book(s):

1. Samuel Y.Liao, " Microwave Devices and Circuits", 3rd Edition, Pearson education, 2003.
2. R.E.Collin, "Foundations for microwave Engineering", 2nd Edition, Tata Mc Graw Hill, 1992.
3. Pozar, David M. "Microwave engineering", 4th Edition, John Wiley & Sons, 2013.

Suggested Reference Book(s):

1. Annapurna Das, Sisir.K.Das, "Microwave Engineering",1st Edition, Tata McGraw Hill, 2000.

Other useful resource(s):

1. Link to topics related to course: https://nptel.ac.in/courses/108101112

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Microwave Theory and Techniques)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	1	2	1	1	2	1	2	2	2	2	1	1.58
CO-2	2	3	3	3	3	1	2	1	1	2	1	1	1.92
CO-3	3	2	2	2	3	1	1	1	2	2	2	1	1.83
CO-4	2	3	3	3	2	1	2	1	1	3	1	2	2.0
CO-5	3	3	3	3	2	1	1	1	2	3	2	1	2.08
CO-6	3	3	2	2	3	1	1	1	1	2	1	2	1.83
Average	2.5	2.5	2.5	2.33	2.33	1.16	1.33	1.16	1.5	2.33	1.5	1.33	

Next Generation Communication Systems

COURSE CODE: 18B1WEC745

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Basic knowledge of wireless communication and probability theory

Course Objectives:

1. To analyze the channel parameters effects on communication system.
2. Understanding of advanced techniques employed for improvement of communication system.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Understand the basics of communication system and various standards used in different generation.	Familiarity
CO-2	Understand the modeling of channel used in communication.	Familiarity
CO-3	Analyze the effect of various parameters on the performance of communication system.	Assessment
CO-4	Demonstrate the various techniques for performance improvement of communication system	Assessment
CO-5	Apply advanced techniques to next generation communication system	Usage

Course Contents:

Unit	Contents	Lectures required
1	CDMA: Introduction to various generation of cellular communication systems and standards, Introduction to CDMA and Spread Spectrum, Generation and Properties of PN Sequences, correlation between PN Sequences, Walsh Code, Variable tree OVSF, LFSR, Rake Receiver, Near-Far effect, Multi user CDMA uplink and downlink.	9
2	Channel Characterization of Next generation communication system: BER and SNR analysis of wired and wireless channels, Effect of various channel parameters on performance of wireless communication system, Doppler shift.	6
3	Diversity & Equalization: Diversity System Model, Receiver Diversity: selection diversity, feedback diversity, maximal ratio combining, equal gain combining, Equalizers, Types of Equalizers: linear equalizers, non-linear equalizers.	9
4	Principles of OFDM and MIMO wireless communication: Introduction to OFDM, OFDM Block Diagram, MIMO Wireless Communication, Benefits of MIMO Technology, MIMO OFDM Building Block, Capacity Comparisons of SISO, SIMO, MISO, and MIMO.	9
5	Singular Value Decomposition, Software Defined Radio , Cognitive Radio	9
Total lectures		42

Suggested Text Book(s):

1. T.S. Rappaport, “Wireless Communication”, 2nd Edition, Prentice Hall.,2002.
2. A.Goldsmith, “ Wireless communication” 1st Edition , Cambridge University Press,2005.
3. Ye Li and Gordon L. Stuber, “Orthogonal Frequency Division Multiplexing for Wireless Communications” 1st Edition, Springer, 2006.

Suggested Reference Book(s):

1. Huseyin Arslan: Cognitive Radio, Software Defined Radio, and Adaptive Wireless Systems, 1st Edition, Springer, 2007.

2. Hui Liu, "OFDM based broadband wireless networks: design and optimization" , 1st Edition, John Wiley & Sons, 2006.

Other useful resource(s):

1. Link to NPTEL course contents: https://nptel.ac.in/courses/117104099/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programmed Outcomes (POs)

Course outcomes (Next Generation Communication Systems)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	3	2	2	1	2	2	2	1	2	2	2	1.92
CO-2	3	3	3	3	2	2	1	1	1	2	2	2	2.08
CO-3	3	3	3	3	2	1	1	1	1	2	1	1	1.83
CO-4	2	3	3	2	2	1	1	1	1	2	1	3	1.83
CO-5	3	2	2	2	3	2	2	1	1	2	2	2	2.00
Average	2.6	2.8	2.6	2.4	2	1.6	1.4	1.2	1	2	1.6	2	

FPGA based Instrumentation System Design

COURSE CODE: 18B1WEC744

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Digital Electronics, Basic Electronics

Course Objectives:

1. Learn and understand the FPGA design flow
2. Learn to implement basic arithmetic circuits and DSP algorithms in FPGA using IP cores.
3. Learn to determine circuit speed, to check timing violations and techniques to fix them.
4. Learn to apply the knowledge gained to break an algorithm into arithmetic functions and implement in FPGA with/without using IP cores.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Explain the concept and basic structures of Field Programmable Gate Array (FPGA), and techniques to implement programmable logic circuits using typical FPGA design flow	Familiarity
CO-2	Implementing basic arithmetic circuits and ASICs for simple DSP functions, such as filters using user defined or vendor provided IP cores	Assessment
CO-3	Determining circuit speed, checking timing violations and techniques to fix the timing violations.	Usage
CO-4	Design issues in cross clock domains communication in high-speed ASIC design	Assessment
CO-5	Break any given algorithm to sub-modules and implement the same on FPGA using HDLs and various IP cores	Usage

Course Contents:

Unit	Contents	Lectures required
1	Introduction to FPGA : From discrete logic to FPGAs, flexibility and functionality, FPGA vs Programmable DSPs, FPGA technology - roadmap, clocking, data and sample rates, slices and configurable logic blocks, memory and registers, performance ratings, families DSP and FPGAs: FPGA elements for DSP algorithms, FPGA- Based System Design Examples	6
2	Verilog HDL: Data types, operators, Multiplexers, decoders, adders, Subtractor, de-multiplexers, flip-flops, counters, state machine, ALU with adder/Subtractor and shifter, multiply and divide hardware synthesis, memory, using a test bench for verification and simulation Concept of state machine and VHDL implementation, simulation synthesis, verification, : FSM Types, Implementation in HDLs, a simple computer design, other Design examples and case studies	12
3	Digital System Design: Combinational and sequential circuits, Classification of sequential circuits, Registers. Design & analysis of synchronous and asynchronous sequential circuits: Counters.	6
4	Embedded Systems & FPGAs: FPGA as a systems on chip platform, FPGA on-chip network standards, FPGAs as custom microcontroller and hybrid DSP microcontroller devices, Multiple cock domains on chip, Multi FPGA systems, multiple-clock domains, program and data memory, SRAM and DRAM., ROM, PAL, and PLA, Timing Constraints, using IP cores: instantiation and simulations	6
5	Instrumentation System: Basic concepts, Weighted Resistor D/A converter, A/D Converter, programmable ICs, digital potentiometers, various data communication and interfacing protocols (UART, SPI, I2C and others) and FPGA implementation case studies	12
Total lectures		42

Suggested Text Book(s):

1. Michael D. Ciletti: Advanced Digital Design with the Verilog HDL, 2nd Edition, Pearson, 2011.
2. Jean- Pierre Deschamps, Gustavo D. Sutter, Enique Cano: Guide to FPGA Implementation of Arithmetic Functions, Springer, 2012.

Suggested Reference Book(s):

1. Hamblen, J.O, Hall, T.S, and Furman, M.D., "Rapid Prototyping of Digital Systems, SOPC Edition." Springer, 2008.
2. Zainalabedin, Navabi, "Digital Design and Implementation with Field Programmable Devices", Springer, 2005.
3. Jean- Pierre Deschamps, Gery Jean Antoine Bioul, Gustavo D. Sutter, "Synthesis of Arithmetic Circuits-FPGA ASIC and Embedded Systems" , a John Wiley & sons, inc, publication, 2006.

Other useful resource(s):

1. FPGA manufacturer's web resources:
   Altera Inc.: https://www.altera.com/products/general/fpga/stratix-fpgas/about/stx-asic-prototyping.html
   Xilinx: https://www.xilinx.com/applications/asic-prototyping.html
2. Other Journal/research resources:
   http://biomedical-engineering-online.biomedcentral.com/articles/10.1186/1475-925X-13-126
   http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.470.6049&rep=rep1&type=pdf
3. NPTEL Resources
   https://nptel.ac.in/courses/117108040/
   https://nptel.ac.in/courses/117106092/55
   https://nptel.ac.in/syllabus/117108040/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (FPGA based Instrumentation System Design)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	2	3	1	2	2	x	1	3	3	1	2	1.67
CO-2	3	2	3	1	2	2	x	x	3	1	1	2	1.67
CO-3	3	3	3	2	3	2	x	x	3	2	1	2	2.00
CO-4	3	3	3	2	3	2	x	x	3	2	1	2	2.00
CO-5	3	3	3	3	3	2	x	x	3	2	1	2	2.08
Average	3	2.6	3	1.8	2.6	2	0	0	3	1.6	1	2	

Optimum Array Processing

COURSE CODE: 18B1WEC743

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Linear Algebra, Signals & Systems and Discrete-Time Signal Processing

Course Objectives:

1. To introduce traditional methods of array signal processing for multi-antenna transceivers.
2. To develop a deeper understanding of several major topics of array processing including spatial filtering (beamforming), direction of arrival estimation.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Extrapolate the fundamentals of arrays, signal models in various domains.	Familiarity
CO-2	Apply the principal techniques of smart beam conformation and estimation of the direction multichannel arrival.	Assessment
CO-3	Design in array processing algorithms that solve specific problems in the field of communications.	Assessment
CO-4	Evaluate the advantages of using multiple antennas for the reception and/or transmission of radio navigation.	Assessment
CO-5	Analyze the implications at system level of the use of antenna arrays in different applications.	Usage

Course Contents:

Unit	Contents	Lectures required
1	Introduction: Array Processing, Applications, Uniform Linear Array, Array Steering, Array Performance Measures, Linear Aperture, Broadband Arrays, Uniform Rectangular Arrays.	6
2	Optimum Waveform Estimation: Optimum Beamformers, Discrete Interference, Spatially Spread Interference, Beamforming for Correlated Signal and Interferences, Broadband Beamformers	8
3	Adaptive Beamformers: Estimation of Spatial Spectral Matrices, Recursive Least Squares (RLS), Gradient Algorithms, LMS Algorithms, Eigenspace and DMR Beamformers.	9
4	Parameter Estimation: Maximum Likelihood (ML) Estimator, Parameter Estimation Model, Cramer-Rao Bounds, Maximum Likelihood Estimation, Quadratic Algorithms, Subspace Algorithms, Sensitivity, Robustness, and Calibration.	10
5	Optimum Detection: Classic Binary Detection, Matched Subspace Detector, Spatially Spread Gaussian Signal Processes, Adaptive Detection.	9
Total lectures		42

Suggested Text Book(s):

1. Harry L. Van Trees: Optimum Array Processing: Part IV of Detection, Estimation, and Modulation Theory, 1st Edition, Wiley-Interscience, 2002.
2. Simon Haykin: Array Signal Processing, 1st Edition, Prentice Hall, 1984.

Suggested Reference Book(s):

1. Jacob Benesty, Israel Cohen, Jingdong Chen: Fundamentals of Signal Enhancement and Array Signal Processing, 1st Edition, Wiley-IEEE Press, 2017.
2. Steven M. Kay: Fundamentals of Statistical Signal Processing, 1st Edition, Prentice Hall, 1993.

Approved in Academic Council held on 25.10.2018

Other useful resource(s):

1. Link to NPTEL course contents: Array Processing and Array Gain with Uniform Linear Arrays https://nptel.ac.in/courses/117104117/16
2. Link to MITOPENCOURESEWARE: Adaptive Antennas and Phased Arrays https://ocw.mit.edu/resources/res-ll-002-adaptive-antennas-and-phased-arrays-spring-2010/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (3) - 10 Quizzes (3) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Optimum Array Processing)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	2	2	2	1	1	1	1	1	2	1	3	1.67
CO-2	3	3	2	2	2	1	1	1	1	2	2	3	1.92
CO-3	3	3	3	2	3	1	1	1	1	2	3	3	2.17
CO-4	3	3	3	3	2	3	2	1	1	3	3	3	2.50
CO-5	3	3	3	3	3	2	1	1	2	3	3	3	2.50
Average	3.00	2.80	2.60	2.40	2.20	1.60	1.20	1.00	1.20	2.40	2.40	3.00	

Antenna and Wave Propagation

COURSE CODE: 18B1WEC742

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

1. To make students understand the fundamental theory and concepts of antenna and propagation of waves.
2. Make them aware to the radiation characteristics of different types of antennas, their measurement and applications of various antennas.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Comprehend the fundamental theory and concepts of radiation, antenna and significance of antenna parameters.	Familiarity
CO-2	Assess the power and usefulness of UHF, VHF and Microwave Antennas, microstrip patch antennas their requirements, specifications, characteristics and design relations.	Assessment
CO-3	To define and distinguish between different phenomenon of wave propagation (ground wave, space wave and sky wave), their frequency dependence, and estimate their characteristics, identifying their profiles and parameters involved.	Assessment
CO-4	Reveal different applications of the various types of antenna to solve engineering and other problems	Usage

Course Contents:

Unit	Contents	Lectures required
1	ANTENNA FUNDAMENTALS: Introduction, Radiation Mechanism – single wire, 2 wire, dipoles, Current Distribution on a thin wire antenna. Antenna Parameters - Radiation Patterns, Beamwidths, Beam Area, Radiation Intensity, Beam Efficiency, Directivity, Gain and Resolution, Antenna Apertures, Aperture Efficiency Antenna temperature and signal to noise ratio.	7
2	RADIATION OF ELECTRIC DIPOLE: Potential functions and the electromagnetic field, Oscillating electric dipole derivations for E and H field components in spherical coordinate systems, Power Radiated by a current element, Application to antennas, Radiation from quarter wave monopole and half wave dipoles, equality of directional patterns and effective lengths of transmitting and receiving antennas, directional properties of dipole antennas, antenna feeding methods.	8
3	ANTENNAS FOR SPECIAL APPLICATIONS: Broadband antenna, Frequency-independent antenna, log periodic antennas, Antennas design consideration for satellite communication, antenna for terrestrial mobile communication systems, GPR, Embedded antennas, UWB, Plasma	6
4	ANTENNA MEASUREMENTS: Radiation Pattern measurement, Distance requirement for uniform phase, uniform field amplitude requirement, Introduction to phase measurement; Gain Measurement: Comparison method, Near field method, Introduction to current distribution measurement, Measurement of antenna efficiency, measurement of Noise figure and noise temperature of an antenna polarization measurement, Anechoic Chamber measurement.	7

5	WAVE PROPAGATION - I: Concepts of Propagation – frequency ranges and types of propagations. Ground Wave Propagation–Characteristics, Parameters, Wave Tilt, Flat and Spherical Earth Considerations. Sky Wave Propagation – Formation of Ionospheric Layers and their Characteristics, Mechanism of Reflection and Refraction, Critical Frequency, MUF & Skip Distance – Calculations for flat and spherical earth cases, Optimum Frequency, LUHF, Virtual Height, Ionospheric Abnormalities, Ionospheric Absorption.	7
6	WAVE PROPAGATION – II: Fundamental Equation for Free-Space Propagation, Basic Transmission Loss Calculations. Space Wave Propagation – Mechanism, LOS and Radio Horizon. Tropospheric Wave Propagation – Radius of Curvature of path, Effective Earth's Radius, Effect of Earth's Curvature, Field Strength Calculations, M-curves and Duct Propagation, Tropospheric Scattering.	7
Total lectures		42

Suggested Text Book(s):

1. E.C.Jordan and Balmain: Electromagnetic waves and Radiating Systems, 2nd Edition, PHI, 2006
2. Constantine A. Balanis: Antenna Theory Analysis and Desin, John Wiley, 2nd Edition,2007.

Suggested Reference Book(s):

1. John D.Kraus, Ronald J Marhefka and Ahmad S Khan: Antennas for all Applications, Tata McGraw-Hill Book Company, 3rd Edition, 2007.
2. G.S.N.Raju: Antenna Wave Propagation, Pearson Education, 1st Edition,2004.
3. R.E.Collins, "Antenna and Radiowave propagation", 3rd Edition, Mc Graw Hill, 2005.

Other resources/ learning website:

www.nptel.ac.in
www.antenna-theory.com

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Antenna and Wave Propagation)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	2	2	3	2	1	1	1	2	3	3	2.17
CO-2	3	3	3	3	3	2	1	1	1	2	2	3	2.25
CO-3	3	3	3	3	3	2	1	1	1	2	2	3	2.25
CO-4	3	3	3	3	3	3	3	2	3	3	3	3	2.92
Average	3	3	2.75	2.75	3	2.25	1.5	1.25	1.5	2.25	2.5	3	2.40

OFDM and Applications

COURSE CODE: 18B1WEC736

COURSE CREDITS: 3

CORE/ELECTIVE: Elective

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

1. Learn the fundamental concepts of high rate OFDM communication system focusing on the physical layer.
2. Analyze the design requirements of various OFDM standards.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Learn the fundamentals of OFDM communication system.	Familiarity
CO-2	Performance analysis of OFDM signals over AWGN and wideband channels.	Assessment
CO-3	Demonstrate the challenging issues in OFDM system.	Assessment
CO-4	Apply OFDM to the practical communication systems.	Usage

Course Contents:

Unit	Contents	Lectures required
1	Introduction and Basics of OFDM: High rate wireless applications; Wireless channel; Interference and noise; OFDM concept and system model- block diagram, design of the OFDM signal, OFDM system model, FFT implementation, cyclic extension, power spectrum and spectrum efficiency, synchronization errors; Channel capacity and OFDM; Comparison with single-carrier; Design example; Performance of an uncoded OFDM system.	10
2	Impairments of Wireless Channels to OFDM Signals: Time varying impairments; Effect of sampling clock offset; Effect of timing offset; Effect of delay spread; System Non Linearity. Other Multicarrier Modulation; Mathematical modeling and analytical evaluation of the BER of OFDM System.	8
3	OFDM Transmission over Gaussian channels and wideband channels. Synchronization: Overview of synchronization schemes- timing offset estimation, frequency offset estimation, acquisition versus tracking; Timing offset estimation-pilot based methods, non-pilot based methods; Frequency offset estimation- pilot based methods, non-pilot based methods; Joint time and frequency offset estimation and correction.	8
4	OFDM versus-MC-CDMA Peak Power Ratio: The peak power problem; Distribution of PAP ratio; Maximum PAPR of an N subcarrier OFDM signal; PAPR reduction with signal distortion; Limits for distortion-less PAPR-reduction; Techniques for distortion-less PAPR reduction-selective mapping, optimization techniques, modified signal constellation; PAPR reduction effect on the system performance; PAPR reduction for multicarrier CDMA.	8
5	OFDM applications: MIMO OFDM- synchronization for MIMO OFDM, A practical OFDM system: Fixed broadband wireless access, system requirements, parameter selection, communication protocol, frame structure, MAC consideration and conformance.	8
Total lectures		42

Suggested Text Book(s):

1. Ye Li and Gordon L. Stuber: Orthogonal Frequency Division Multiplexing for Wireless Communications,

1st Edition, Springer, 2006.
2. Ramjee Prasad: OFDM for Wireless Communications Systems, 1st Edition, Artech House Publishers, 2004.
3. Lazos Hanzo: OFDM and MC-CDMA: A primer, 1st Edition, Wiley-IEEE Press, 2006

Suggested Reference Book(s):

1. Richard Van Nee: OFDM for Wireless Multi-Media Communication, 1st Edition, Artech, House Publishers, 2000.
2. Hui Liu: OFDM based Broadband Wireless Networks: Design and Optimization, 1st Edition, John Wiley & Sons, 2006.

Other useful resource(s):

1. Link to NPTEL course contents: https://nptel.ac.in/courses/117104099/
2. Link to topics related to course:
   https://nptel.ac.in/courses/117104099 /27
   https://nptel.ac.in/courses/117104099 /28
   https://nptel.ac.in/courses/117104099 /29
   https://nptel.ac.in/courses/117104099 /30
   https://nptel.ac.in/courses/117104099 /31
   https://nptel.ac.in/courses/117104099 /34

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (OFDM and its Applications)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	2	3	1	3	1	1	1	2	2	1	3	1.92
CO-2	3	3	3	3	3	2	1	1	2	2	1	3	2.25
CO-3	2	2	3	3	2	1	1	1	2	1	1	3	1.83
CO-4	2	1	3	3	3	2	1	1	1	1	1	2	1.75
Average	2.5	2	3	2.5	2.75	1.5	1	1	1.75	1.5	1	2.75	

Robotic Systems and Control

COURSE CODE: 18B1WEC737

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Differential equations and Linear algebra, knowledge of Control Systems

Course Objectives:

1. The Robotics' chief objective has always been associated with working for new and updated technologies for example embedded systems, microcontrollers and VLSI.
2. To use the robotic system for logic building & programming and to solve many engineering problems.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Students will be equipped with the automation and brief history of robot and applications.	Familiarity
CO-2	Students will be equipped with the principles of various sensors, actuators and their applications in robots.	Assessment
CO-3	Be able to analyze any physical system using mathematical model.	Assessment
CO-4	Be able to do the path planning on robotic systems using various control strategies.	Assessment
CO-5	Students will be equipped with the simulation and hands on robotic kits	Usage

Course Contents:

Unit	Contents	Lectures required
1	Introduction to Robotics: Introduction – brief history, types, classification and usage, Science and Technology of robots, textbooks and research journals, introduction to simulation environment.	3
2	Elements of Robots -- joints, links, actuators, and sensors: Position and orientation of a rigid body, Homogeneous transformations, Representation of joints, link representation using D-H parameters, Examples of D-H parameters and link transforms, different kinds of actuators – stepper, DC servo and brushless motors, model of a DC servo motor, Types of transmissions, Purpose of sensors, internal and external sensors, common sensors – encoders, tachometers, strain gauge based force- torque sensors, proximity and distance measuring sensors, and vision.	10
3	Robot Arm Kinematics and Dynamics: forward kinematics, Inverse kinematics, Lagrange formulation of dynamics	8
4	Motion Planning and Control: Joint and Cartesian space trajectory planning and generation, Classical control concepts using the example of control of a single link, Independent joint PID control, Control of a multi-link manipulator, Non-linear model based control schemes, Simulation and experimental case studies on serial and parallel manipulators	10
5	Modeling and Control of Flexible Robot Manipulators: Models of flexible links and joints, Kinematic modeling of multi-link flexible robots, Dynamics and control of flexible link manipulators, Numerical simulations studies	6
6	Robot Programming: MATLAB and other simulation platforms, Hands on experiment on robotic kits, working and implementing various Ad-on modules.	5
Total lectures		42

Approved in Academic Council held on 25.10.2018

Suggested Text Book(s):

1. J. J. Craig, "Introduction to Robotics- Mechanics and Control", Pearson, 3rd Edition, 2009.
2. Spong and Vidyasagar, "Robot Dynamics and Control", Wiley Student Edition, John Wiley and Sons, 2013.

Suggested Reference Book(s):

1. Sciavicco and Siciliano, "Modeling and Control of Robot Manipulators", Springer, 2nd Edition, 2002.
2. D.K. Pratihar, "Fundamentals of Robotics", Narosa Publishing House, 1st Edition, 2017.

Other useful resource(s):

1. Link to NPTEL course contents: https://nptel.ac.in/courses/112101099/
2. Other links to course material: https://nptel.ac.in/downloads/112101098/
3. Material provided by IIT Bomaby under eLSI project

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignments (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Robotic Systems and Control)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	2	2	2	2	1	1	1	2	3	3	1.9
CO-2	3	3	3	2	3	2	1	1	1	1	2	3	2
CO-3	3	3	3	3	3	3	2	1	3	2	2	3	2.6
CO-4	3	3	3	3	3	3	2	1	2	2	3	3	2.5
CO-5	3	3	3	3	3	3	2	1	2	1	2	3	2.4
Average	3	3	2.8	2.6	2.8	2.6	1.6	1	1.8	1.6	3	3	

Time-Frequency Analysis and Applications

COURSE CODE: 18B1WEC738

COURSE CREDITS: 3

CORE/ELECTIVE: Elective

L-T-P: 3-0-0

Pre-requisite: Signals and Systems

Course Objectives:

1. Study and analyze various spectral analysis and time-frequency analysistools.
2. Study the time-frequency analysis tools based algorithm for different applications.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Understand the concept of the spectral analysis.	Familiarity
CO-2	Familiar with the basics concept of the short time Fourier transform /continuous wavelet transform.	Assessment
CO-3	Understand the basic concept of the distribution based Time-Frequency Analysis tools.	Assessment
CO-4	Develop the TFA based algorithms for various applications.	Usage

Course Contents:

Unit	Contents	Lectures required
1.	Introduction to spectral analysis: Parametric and Non-Parametric methods.	6
2.	Basics of Time Frequency Analysis: Basic Concepts & Definition, Duration-Bandwidth Principle, Joint Energy Density, Short-time FT, its Properties & Applications, MATLAB based implementation of STFT	6
3.	Wavelet transforms: Continuous Wavelet Transform and its Computational aspects, Scale to Frequency conversion, Scalogram, Scaling Function and Wavelets, Applications of CWT, MATLAB based implementation of wavelet transform.	8
4	Distributions based time-frequency tools: Wigner-Ville Distributions, Interference in WVD, its Applications, Cohen's class, Smoothed WVD, Ambiguity Functions, Affine Class, and MATLAB based implementation of distribution based time-frequency analysis tools.	8
5.	Case studies: Radar and Sonar, Economic Data Analysis with the Gabor Spectrogram, Gabor Spectrogram in Ultrasonic Nondestructive Materials testing, Applications of Time-Frequency Analysis in spectrum sensing, Biomedical signal processing, Genomics data analysis.	14
Total lectures		42

Suggested Text Book(s):

1. Hayes MH. Statistical digital signal processing and modeling. John Wiley & Sons; 2009.
2. Boashah B. Time-frequency signal analysis and processing: a comprehensive reference. Academic Press; 2015.

Suggested Reference Book(s):

1. S. Mallat, A Wavelet Tour of Signal Processing - The Sparse Way. Elsevier, Third Edition, 2009.
2. Cohen, Leon, Time-frequency analysis. Vol. 778. Prentice hall, 1995.
3. Chen, Victor C., and Hao Ling. Time-frequency transforms for radar imaging and signal analysis. Artech house, 2002.

Other useful resource(s):

1. http://nptel.ac.in/courses/117101001/: The lecture series on Wavelets and Multi-rate Digital Signal Processing

created by Prof. Vikram M. Gadre in NPTEL.

2. Time-frequency toolbox (MATLAB) is available for download from http://tftb.nongnu.org/
3. http://nptel.ac.in/courses/117101001/1

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Time-Frequency Analysis and its Applications)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	3	2	2	2	1	1	1	1	3	3	3	2
CO-2	2	3	3	3	3	1	1	1	2	3	3	3	2.3
CO-3	3	3	3	3	3	1	1	1	2	3	3	3	2.4
CO-4	3	3	3	3	3	3	3	3	3	3	3	3	3
Average	2.5	3	2.75	2.75	2.75	1.5	1.5	1.5	2	3	3	3	

Design of Modern Antennas

COURSE CODE: 18B1WEC852

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Transmission lines and E.M waves.

Course Objectives:

The main objective of the course is to

1. Learn the mechanism of antenna, antenna performance parameters.
2. Design and analysis of various antennas for different applications.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	To define overall needs and constraints of RF systems and antennas.	Familiarity
CO-2	To understand the mechanism of antenna radiation.	Familiarity
CO-3	To design and analyze various antennas for specific application.	Usage
CO-4	Size reduction techniques, Broad banding and multi band operation techniques in antenna design.	Usage
CO-5	Evaluate the opportunities involving technology, a product or a service required for developing a startup idea.	Assessment

Course Contents:

Unit	Contents	Lectures required
1.	Introduction: antenna types, radiation mechanism, use of potential functions, radiated field, far field, antenna parameters, radiation pattern, directivity, numerical evaluation of directivity, gain, efficiency, impedance, loss resistance, polarization, linear polarization, circular and elliptic polarization, equivalent area, Friss equation.	6
2.	Dipole Antennas: Potential functions for analysis of radiated fields, Duality theorem, Reciprocity theorem for antennas, Radiation from current element, infinitesimal dipole, finite length dipole, half wave dipole	6
3.	Antenna Arrays: Analysis and Synthesis Review of antenna array basics, Linear arrays, circular array, planar (2D) arrays, sum and difference patterns, Effect of mutual couplings, Phased array antennas, scan Principles, Non uniform arrays, Dolph Chebyshev Arrays Binomial Arrays.	6
4	Broadband and Frequency Independent Antennas Helical antenna: Normal mode and axial mode helix Spiral antennas, Log Periodic antennas.	5
5.	Aperture Antennas Radiation from an aperture in an infinite ground plane, Radiation from rectangular and circular apertures, Radiation from a slotted rectangular waveguide Horn antenna: E plane and H plane sectoral horns, Pyramidal horn, Conical horn Reflector antennas parabolic reflector, methods of analysis, dual reflector antennas, offset reflector antenna, gain and efficiency calculations, scanning properties and cross polarization Lens antennas and their applications	7
6	Microstrip Antennas Rectangular patch antenna: cavity and transmission line models, Circular patch antenna Coupling mechanisms, circular polarization, Microstrip arrays, Broadband and Multi band microstrip antennas, Compact Microstrip Antennas.	7
7	Dielectric Resonator Antennas Introduction, radiation mechanism, advantages of DRA, types of DRA, feeding techniques, design method, modes.	5
Total lectures		42

Suggested Text Book(s):

1. Constantine A. Balanis: Antenna Theory Analysis and Desin, John Wiley, 3rd Edition, 2009.
2. Antennas for All Applications, J. D. Kraus and R. J. Marhefka, McGraw-Hill, Inc, 3rd Ed., 2007.

3. Rectangular Dielectric Resonator Antennas, Rajveer S. Yaduvanshi Harish Parthasarathy, Springer, 1st Ed, 2016.

Suggested Reference Book(s):

1. Antennas and Radio wave Propagation, R. E. Collin, McGraw-Hill, Inc, 3rd Ed, 2005.
2. Modern Antenna Design, T. A. Milligan, John Wiley & Sons, 2nd Ed., 2005.
3. Antenna Arrays, R. L. Haupt, John Wiley & Sons, Inc., 1st Ed., 2010.
4. Antenna Theory and Microstrip Antennas, D. G. Fang, CRC Press, 1st Ed., 2009.

Other useful resource(s):

Link to NPTEL course contents

1. https://nptel.ac.in/courses/108101092/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered up to T-1
2	T-2	25	1.5 Hours	Syllabus covered up to T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes(2) -10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Design of Modern Antennas)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	3	3	3	2	1	1	1	2	2	2	2.2
CO-2	2	3	3	3	2	2	1	1	2	1	1	2	1.9
CO-3	2	2	2	3	2	2	1	1	1	2	1	3	1.8
CO-4	2	2	3	3	2	1	1	2	2	2	2	2	2
CO-5	2	2	3	3	3	2	1	1	2	2	1	2	2
Average	2.2	2.4	2.8	3	2.4	1.8	1	1.2	1.6	1.6	1.4	2.2	

Soft Computing Techniques

COURSE CODE: 18B1WEC851

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

1. Develop the skills to gain a basic understanding of neural network theory and fuzzy logic theory.
2. Introduce students to artificial neural networks and fuzzy theory from an engineering perspective

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Comprehend the fuzzy logic and the concept of fuzziness and concepts of neural networks	Familiarity
CO-2	Demonstrate knowledge representation using fuzzy rules, approximate reasoning, fuzzy inference systems, and fuzzy logic	Assessment
CO-3	Understand appropriate learning rules for each of the architectures and learn several neural network paradigms and its applications	Assessment
CO-4	Apply fuzzy rules and neural network learning rules and design paradigms to solve engineering and other Problems.	Usage

Course Contents:

Unit	Contents	Lectures required
1	Introduction to fuzzy set theory: Probabilistic reasoning, Fuzzy sets, mathematics of fuzzy set theory, operations on fuzzy sets, comparison of fuzzy and crisp set theory.	4
2	Fuzzy mapping: one to one mapping, max-min principle, extension principle, implication rules – mamdani implications. Membership functions: Universe of discourse, mapping inside fuzzy domain, fuzzy membership mapping methods, and application to real world problems.	10
3	Artificial Neural Networks (ANN) and their biological roots and motivations. Comparison Between Artificial and Biological Neural Networks, Applications of Neural network. Network Architecture ,Taxonomy of neural networks: feed forward and recurrent networks with. Merits and limitations of neurocomputing.	8
4	Types of learning, supervised and unsupervised learning laws . Learnig Laws : Hebb's rule, Delta rule, Widrow - Hoff (The Least-Mean-Square) learning rule, correlation learning rule, instar and outstar learning rules, Competitive learning, Credit Assignment Problem, Error Correction learning, Memory based learning.	9
5	The Perceptron and its learning law, Classification of linearly separable patterns, Multi-Layer Perceptron, Supervised Learning, Back-Propagation Learning law. Feed forward networks, Recurrent Networks.	6
6	Winner takes-all Networks, Competitive Learning, Kohonen's Self organizing Maps, Introduction to Adaptive Resonance Theory.	5
Total lectures		42

Suggested Text Book(s):

1. Simon Haykin: Artificial Neutral Networks, 2nd Edition, Pearson, 2008.
2. Yegna Narayanan: Artificial Neural Networks, 2nd Edition, Prentice-Hall of India, 2010.
3. S.N. Sivanandam, S.N Deepa: Principles of Soft Computing, 3rd Edition, Wiley, 2019.

Approved in Academic Council held on 25.10.2018

Suggested Reference Book(s):

1. Bart Kosko: Neural Network and Fuzzy Systems: A Dynamic System Approach to Machine, Prentice-Hall 1998
2. L. Fausett: Fundamentals of Neural Networks: Architectures, Algorithms, and Applications, Prentice-Hall, Reprint 2013
3. Jack M. Zurada: Introduction to Artificial Neural Systems, PWS Publishing Co., 2nd Edition, 2002.

Other useful resource(s):

Link to NPTEL course contents

1. http://nptel.ac.in/courses/117105084/
2. http://nptel.ac.in/courses/108104049/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Soft Computing Techniques)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	2	2	2	3	2	1	1	1	2	2	2	1.92
CO-2	3	2	3	3	3	1	1	1	1	2	2	2	2.00
CO-3	3	2	3	3	3	2	1	1	1	2	2	2	2.08
CO-4	3	3	3	3	3	2	3	1	1	3	3	3	2.58
Average	3	2.25	2.75	2.75	3	1.75	1.5	1	1	2.25	2.25	2.25	2.15

Fault-Tolerant Communication Systems

COURSE CODE: 18B1WEC850

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Computer Communication Network

Course Objectives:

1. Apply the concepts of reliability and fault-tolerance for the communication systems.
2. Propose the communication system design approach for the service predictability.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Historical background and basic approaches of fault-tolerance in communication system.	Familiarity
CO-2	Integration of integrity, survivability, availability, protection & restoration.	Familiarity
CO-3	Routing schemes used for fault-tolerance.	Assessment
CO-4	Planning and testing of fault-tolerant architectures.	Assessment
CO-5	Fault-tolerant planning for the development of mission-critical communication and systems.	Usage

Course Contents:

Unit	Contents	Lectures required
1	Historical perspective, best-effort service, guaranteed service, QoS. Fault, Failure and Error, reliability engineering in network design. Performance failure, breakdown failure, reliability, resiliency and performability.	6
2	Network availability, protection & restoration. Continuity and availability in communication network, Concepts and methodology of protection and restoration.	9
3	Fault-tolerant planning for MPLS based network, Optical networks and SONET/SDH network.	8
4	Fault-tolerant schemes for ad-hoc networks, sensor network and IoT.	8
5	Development routing schemes for handling proactive and passive faults.	6
6	Mission-critical network planning considering faults failure and recovery.	5
Total lectures		42

Suggested Text Book(s):

1. Jean-Philippe Vasseur, Mario Pickavet, Piet Demeester, Network Recovery: Protection and Restoration of Optical, SONET-SDH, IP, and MPLS, Elsevier, 1st edition, 2004.
2. Mathew Liotine, Mission-Critical Network Planning, Artech House, 1st edition, 2003.
3. Dhiraj K. Pradhan, Fault-tolerant Computer System Design, Prentice-Hall, 1st edition, 1996.

Suggested Reference Book(s):

1. Martin L. Shooman, Reliability of Computer Systems and Networks: Fault Tolerance, Analysis, and Design, John Wiley & Sons, 1st edition, 2002.
2. Arun K. Somani, Survivability and Traffic Grooming in WDM Optical Networks, Cambridge University Press,1st edition,2006.

Other useful resource(s):

1. Link to NPTEL course contents:

i. https://nptel.ac.in/courses/107106009/13,
ii. https://nptel.ac.in/courses/106106168/12

2. Link to topics related tocourse:
   i. http://www.staff.city.ac.uk/~sm377/FTcourse.html
   ii. http://www2.cs.uidaho.edu/~krings/CS449/index.html
   iii. http://euler.ecs.umass.edu/ece655/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) – 10 Quizzes(2) -10 Attendance – 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Fault Tolerant Communication Systems)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	2	2	2	2	2	2	2	2	2	2	2	2.08
CO-2	2	3	3	3	1	1	3	3	3	2	1	1	2.16
CO-3	2	2	2	3	1	1	2	1	2	2	2	3	1.91
CO-4	3	1	3	2	3	2	1	2	2	3	1	2	2.08
CO-5	3	2	3	3	2	2	2	3	1	2	2	3	2.33
Average	2.6	2	2.6	2.6	1.8	1.6	2	2.2	2	2.2	1.6	2.2	

Cognitive Radio Networks

COURSE CODE: 18B1WEC849

COURSE CREDITS: 3

CORE/ELECTIVE: Elective

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

1. To understand the principles, applications and challenges of cognitive radio technology.
2. Analyze the design of wireless networks based on cognitive radio technology.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Understand the fundamental issues regarding dynamic spectrum access and radio-resource management.	Familiarity
CO-2	Analyze the emerging issues in cognitive radio network.	Assessment
CO-3	Apply different spectrum sharing models in the Cognitive Radio Network.	Assessment
CO-4	Apply efficient sharing of the unutilized spectrum among cognitive and licensed users while avoiding interference to the licensed user due to cognitive user's transmission	Usage

Course Contents:

Unit	Contents	Lectures required
1	Introduction to Cognitive Radio: Spectrum scarcity, Spectrum white space, Fixed spectrum allocation, Software defined radio (SDR), Limitations of SDR, Evolution of cognitive radio, Dynamic spectrum access, Introduction to cognitive radio concept, Cognitive cycle, Functions of cognitive radio; spectrum sensing, spectrum management, spectrum mobility, Cognitive radio architecture, Interference temperature and its models.	8
2	Spectrum Sensing and Challenges in Cognitive Radio Network: Hypothesis model for spectrum sensing, Types of spectrum sensing; Non-cooperative sensing, Cooperative sensing, Interference-based sensing, Matched filter detection, Energy detection, Cyclostationary feature detection, advantages and disadvantages of various spectrum sensing techniques, False alarm, Miss detection, Optimal sensing framework for infrastructure based cognitive radio network. Research challenges in spectrum sensing, spectrum management and spectrum mobility, potential applications of cognitive radio, IEEE 802.22 for WRANs	8
3	Spectrum Sharing and Management: Dynamic spectrum Access (DSA): models and architectures, Opportunistic spectrum access (OSA), Antenna Systems, MIMO systems, Smart antenna and beamforming. SDR architecture, Software tunable analog radio components, Reconfigurable digital radio technologies.	8
4	Cross Layer Adaptation and Security in Cognitive Radio: Why we need cross-layer design, adaptation and optimization, Cognitive radio cross layer design, security challenges in cognitive radio. OFDM for Cognitive Radio: OFDM based cognitive radio, Why OFDM is a good fit for Cognitive radio, Challenges to cognitive OFDM systems, Multiband OFDM, A step toward cognitive-OFDM: standards and technologies.	9
5	Cognitive Radio Regulation and Standardization: regulatory issues and new spectrum management regimes, spectrum planning, Spectrum authorization, Standards and international activities. UWB Cognitive Radio: Introduction, Fundamentals of impulse radio Ultra Wideband, Cognitive radio requirements versus IR-UWB, Merging impulse radio with cognitive radio.	9
Total lectures		42

Suggested Text Book(s):

1. Ekram Hossain, Dusit Niyato and Zhu Han: Dynamic Spectrum Access and Spectrum Management in Cognitive Radio Networks, 1st Edition, Cambridge University Press, 2009.
2. Huseyin Arslan: Cognitive Radio, Software Defined Radio, and Adaptive Wireless Systems, 1st Edition, Springer, 2007.
3. Bruce A. Fette: Cognitive Radio Technology, 2nd Edition, Academic Press, April 6, 2009.

Suggested Reference Book(s):

1. Yang Xiao and Fei Hu: Cognitive Radio Networks, 1st Edition, CRC Press, 2008.
2. Linda E. Doyle: Essentials of Cognitive Radio, 1st Edition, Cambridge University Press, 2009.

Other useful resource(s):

Link to GIAN IIT Kanpur course contents (10 lecture series):
https://www.youtube.com/watch?v=SljXFf0vgvw&list=PL48UwQJyfW3SmrjLgl5LrVciqfWz9XazY

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Cognitive Radio Networks)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	2	2	2	2	1	2	1	2	2	3	2.08
CO-2	3	3	3	3	2	1	1	1	2	2	1	2	2
CO-3	3	3	3	2	2	2	1	2	2	2	1	3	2.17
CO-4	3	3	3	3	2	1	1	1	2	3	2	3	2.25
Average	3	3	2.75	2.5	2	1.5	1	1.5	1.75	2.25	1.5	2.75	

RF Engineering

COURSE CODE: 18B1WEC848

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Basic knowledge of Electromagnetic Engineering

Course Objectives:

1. To lay strong foundations in RF and microwave engineering.
2. To apply the theoretical knowledge acquired in the design of different components in microwave systems.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	To have a thorough knowledge of RF and microwave components	Familiarity
CO-2	To have a thorough knowledge about different parameters involved in microwave receiver and their significance	Assessment
CO-3	To have a thorough knowledge about different parameters involved in microwave receiver and their significance	Assessment
CO-4	To design different RF filters according to certain specifications	Usage
CO-5	To understand active microwave components and their use in different applications	Usage

Course Contents:

Unit	Contents	Lectures required
1	Review of Waves and Transmission Lines: Wave Propagation, Transmission Line Equations, Reflection, Transmission, and impedance for a Terminated Transmission Line, Voltage Standing-Wave Ratio, Decibels, insertion Loss, Return Loss, Smith Charts, S-Parameters, Impedance Matching Networks.	5
2	Receiver System Parameters: Typical Receivers, System Considerations, Natural Sources of Receiver Noise, receiver Noise Figure and Equivalent Noise Temperature, Compression Points, Minimum detectable Signal and Dynamic Range, Third-Order Intercept Point and Intermodulation, spurious Responses, Spurious-Free Dynamic Range	8
3	Transmitter and Oscillator Systems: Transmitter Parameters, Transmitter Noise, Frequency Stability and Spurious Signals, Frequency Tuning, Output Power, and Efficiency, Intermodulation, Crystal Reference Oscillators, Phase-Locked Oscillators, frequency Synthesizers	6
4	Design of RF filters: Periodic Structures, Filter Design by the Image Parameter Method, Filter Design by the Insertion Loss Method, Characterization by Power Loss Ratio Filter transformations, Filter Implementation, Stepped-Impedance Low-Pass	9
5	Fabrication Technologies: Lumped Elements for RF circuits: Basic Design of Lumped elements, Lumped element modeling, printed inductors, MIM capacitor and Interdigital capacitor, Monolithic Integrated circuit technology (MIC), Monolithic microwave integrated circuit (MMIC) technology, material, RF printed circuit boards.	9
6	Wireless Communication Systems: Friis Transmission Equation, Space Loss, Link Equation and Link budget, Effective Isotropic Radiated Power and G/T Parameters, Radio/Microwave Links, Satellite Communication Systems, Mobile Communication Systems and Wireless cellular phones, Personal Communication Systems	5
Total lectures		42

Suggested Text Book(s):

1. Kai Chang, "RF and Microwave Wireless Systems",1st Edition, John Wiley & Sons, 2002.
2. Pozar, David M. "Microwave engineering", 4th Edition, John Wiley & Sons, 2013.
3. Bahl I.J "Lumped Elements for RF and Microwave Circuits"1st Edition, Artech House,2003.

Suggested Reference Book(s):

1. R.E.Collin, "Foundations for microwave Engineering", 2nd Edition, John Wiley & Sons, 2007.
2. Annapurna Das, Sisir.K.Das, "Microwave Engineering",1st Edition, Tata McGraw Hill, 2000.

Other useful resource(s):

Link to NPTEL course contents:

https://nptel.ac.in/courses/117101119/

https://nptel.ac.in/courses/117105138/

Link to topics related to course:

https://nptel.ac.in/courses/117105138/ 1 to 18

https://nptel.ac.in/courses/117101119/ 1 to 14

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (RF Engineering)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	2	1	1	1	2	1	2	1.7
CO-2	2	3	2	3	2	2	1	1	1	2	1	2	1.8
CO-3	3	3	3	3	3	2	1	1	1	2	1	2	2.1
CO-4	2	2	2	2	2	2	1	1	1	3	1	2	1.8
CO-5	3	2	3	2	2	2	1	1	1	2	1	2	1.8
Average	2.4	2.4	2.4	2.4	2.2	2.0	1.0	1.0	1.0	2.2	1.0	2.0	

Medical Image Processing

COURSE CODE: 18B1WEC847

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

1. To introduce various medical imaging modalities.
2. To teach the requirement and development of different blocks of computer aided diagnosis for medical images.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Able to understand different types of medical imaging modalities and would be able to differentiate them with respect to their advantages and limitations.	Familiarity
CO-2	Acquire an ability to analyze and process medical images.	Usage
CO-3	Understand different feature extraction techniques and classifiers used for image classification.	Usage
CO-4	Understand the role of computer aided diagnosis for medical images.	Assessment

Course Contents:

Unit	Contents	Lectures required
1	Introduction to Image Processing:- Acquisition of Images, Image Sampling and quantization; Spatial and histogram based enhancement; Noise modeling, Image restoration. Image transformation.	8
2	Edge Detection and Image Segmentation: Gradient based edge detectors. Intensity thresholding based image segmentation; Region growing and region splitting algorithm; watershed segmentation.	8
3	Medical Imaging Modalities: Working principle, applications and limitations of Computed tomography , X-ray, Magnetic resonance imaging, Ultrasound imaging, and Positron emission tomography; Various Artifacts.	6
4	Image Texture: Types of texture parameters: Statistical analysis of texture (First order statistics and Second order statistics), Grey level co-occurrence matrix, grey-level run length matrix.	8
5	Pattern classification: Supervised and Unsupervised pattern classification, Neural Network classifier, Support Vector Machines.	6
6	Case Studies: Pre-processing, Segmentation, Feature extraction, and Classification of medical images.	6
Total lectures		42

Suggested Text Book(s):

1. Chris Solomon, Toby Breckon: Fundamental of Digital Image Processing, 1st Ed., John Wiley & Sons, 2011.
2. Rangaraj M. Rangayyan: Biomedical Image Analysis, 1st Ed., CRC Press, New York , 2004.

Suggested Reference Book(s):

1. RC Gonzalez, RE Woods, Digital Image Processing, 3rd Ed., Pearson Publisher, 2008.
2. Kayvan Najarian, Robert Splinter: Biomedical Signal and Image Processing, 2nd Ed., CRC Press, 2012

3. Tamal Bose: Digital Signal and Image Processing, 1st Ed., John Wiley & Sons, 2003.

Other useful resource(s):

http://www.nptelvideos.in/2012/12/digital-image-processing.html (Prof P.K. Biswas, IIT Kharagpur)

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes(2) -10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Medical Image Processing)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	3	3	3	3	2	3	1	2	1	2	2.42
CO-2	3	3	3	3	2	0	0	1	2	3	1	1	1.83
CO-3	3	3	3	3	3	1	1	1	1	2	1	1	1.92
CO-4	3	3	3	3	3	3	2	3	2	2	3	3	2.75
Average	3.00	3.00	3.00	3.00	2.75	1.75	1.25	2.00	1.50	2.25	1.50	1.75	

Design of Dependable Systems

COURSE CODE: 18B1WEC846

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Graph Theory and Computer Communication Network

Course Objectives:

1. Incorporate the concepts of dependability in the design of critical systems.
2. Propose an architectural framework for the design of systems based on information and communication technologies.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Introduction to dependability attributes such as availability, reliability, safety, QoS, SLA in systems.	Familiarity
CO-2	Familiarization with dependability analysis approaches.	Familiarity
CO-3	Application of methodologies used dependability modeling.	Usage
CO-4	Design of dependability schemes on practical systems.	Usage
CO-5	Evaluation of survivability of networks, dependability evaluation of networks.	Assessment

Course Contents:

Unit	Contents	Lectures required
1	Introduction to Dependability attributes: availability, reliability, safety, QoS, SLA.	5
2	Analysis Approach of Dependability: The failure process, failure semantics, fault handling and maintenance, failure rate, probability distributions, series/parallel systems, Markov models.	6
3	Dependability modeling: Block diagrams and state diagrams - discrete and continuous time Markov models. Fault Trees and Fault Injection. Modeling of software failure, prediction of software failure rates, and impact of software failures on systems behavior.	8
4	Design of Dependability: Fault tolerance, types of redundancy, design principles and mechanisms. Fault detection, tolerance and recovery, Lifetime improvement.	8
5	Prediction of hardware failure rates: Software/hardware and architectural approaches space, information and time redundancy. Design for testability. Model-driven approaches Diagnosis.	7
6	Internet QoS, survivability of networks, dependability evaluation of networks taking the traffic carrying (QoS) requirements into account. QoS guarantee analysis. Some applications of dependability in IT related services.	8
Total lectures		42

Suggested Text Book(s):

1. Ajit Kumar Verma, Srividya Ajit, Dependability of Networked Computer-based Systems, Springer Series in Reliability Engineering, 1st edition, 2013.

2. J.C. Geffroy, G. Motet, Design of Dependable Computing Systems, Springer-Science-Business Media B.V., 1st edition, 2002.

3. J.C. Laprie, Dependability: Basic Concepts and Terminology, Springer-Verlag,1st edition,1992.

Suggested Reference Book(s):

1. Dhiraj K. Pradhan, Fault-tolerant computer system design, Prentice-Hall,1st edition, 1996.
2. M.L. Shooman, Reliability of Computer Systems and Networks: Fault Tolerance, Analysis, and Design, Wiley, 1st edition, 2002.
3. Krishna B. Misra, Handbook of Performability Engineering, Springer, 1st edition,2008.

Other useful resource(s):

1. Link to NPTEL course contents: https://onlinecourses.nptel.ac.in/noc16_oe01/preview
2. Link to topics related to course:https://www.mdh.se/utbildning/livslangtlarande/prompt/design-of-dependable-and-fault-tolerant-embedded-systems-1.120193?l=en_UK

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Design of Dependable Systems)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	2	2	1	2	2	2	2	2	2	2	2	2
CO-2	2	2	2	2	3	2	2	1	1	3	2	2	2
CO-3	3	2	2	2	2	3	3	2	2	2	3	2	2.33
CO-4	2	3	2	3	3	2	3	2	3	3	2	3	2.6
CO-5	2	2	3	2	2	3	3	1	2	2	2	2	2.16
Average	2.4	2.2	2.2	2	2.4	2.4	2.6	1.6	2	2.4	2.2	2	

Artificial Intelligence Techniques

COURSE CODE: 18B1WEC838

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Prerequisites are good programming skills, basic data structures and algorithms, and some university level mathematics.

Course Objectives:

1. Learn to create expert systems which exhibit intelligent behavior.
2. Learn to create expert systems which exhibit the capability to learn, demonstrate, explain and advice its users.
3. Learn to help machines finding solutions to the complex problems.
4. Learn to design human like machines in a computer friendly manner.
5. To study State of the Art algorithms with engineering applications.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Analyze the need and foundation of Artificial Intelligence	Familiarity
CO-2	Study the Intelligent agents that receive percepts from the environment and perform actions	Assessment
CO-3	Analysis of problem solving, knowledge and reasoning	Assessment
CO-4	Study of application domains.	Usage

Course Contents:

Unit	Contents	Lectures required
1	Introduction to Artificial Intelligence (AI): The History and foundations of AI, Philosophy of AI, Intelligent Agents and Knowledge based Systems, AI Problem Solving, AI Learning and AI Perception, Real World AI.	8
2	Intelligent Agents: Agents and Environments, The concept of Rationality, Performance Measures, The structure of Agents, Agent Programs, Simple reflex Agents, Model based reflex Agents, Goal based Agents, Utility based Agents, Learning Agents.	8
3	Problem Solving: Problem solving Agents, Formulating Problems, Searching for Solutions, Uninformed Search Strategies, Breadth first search, Depth first search, Depth limited Search, Bidirectional search, Informed Search Exploration, Constraint Satisfaction Problems.	7
4	Knowledge and Reasoning: Knowledge based agents, Reasoning Patterns in Propositional Logic, Forward and Backward Chaining, Back tracking Algorithm, First Order Logic, Knowledge Representation, Uncertain Knowledge and Reasoning	7
5	Learning, Perception and Action: Learning from Observations, Forms of Learning, Inductive Learning, Learning Decision Trees, Ensemble Learning, Knowledge in Learning, Statistical Learning, Reinforcement Learning, Perceptional Analysis, Communication as Action	6
6	Applications of AI Techniques: Semantic Interpretation, Probabilistic Language Processing, Robotic Hardware and Software Architectures, Probabilistic Inference, Planning and Search, Localization, Tracking and Control.	6
Total lectures		42

Suggested Text Book(s):

1. Stuart J. Russel and Peter Norvig: Artificial Intelligence: A Modern Approach, Third Edition, Pearson Education Limited, 2014.
2. E. Rich and K. Knight: Artificial Intelligence and Applications, Third Edition, Tata McGraw Hill, 2012.

Suggested Reference Book(s):

1. P. Kulkarni and P. Joshi: Artificial Intelligence, Second Edition, PHI Learning Private Limited, 2015.
2. P. H. Winston: Artificial Intelligence and Applications, Third Edition, PHI Learning Private Limited, 2017.

Other useful resource(s):

Link to topics related to course:

https://nptel.ac.in/courses/106105077/
https://nptel.ac.in/courses/106105079/
https://www.tutorialspoint.com/artificial_intelligence/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Artificial Intelligence Techniques)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	3	3	2	1	1	1	2	2	2	2	1.91
CO-2	3	3	3	3	3	2	1	1	3	2	1	3	2.33
CO-3	2	3	2	2	2	2	2	2	2	2	1	2	2.00
CO-4	3	3	3	3	2	1	1	1	2	3	2	3	2.25
Average	2.50	2.75	2.75	2.75	2.25	1.50	1.25	1.25	2.25	2.25	1.50	2.50	

Radar Principles and Applications

COURSE CODE: 18B1WEC839

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Basic Knowledge of Electromagnetic Engineering

Course Objectives:

1. To acquire fundamentals of radar systems.
2. To identify different components used in radar system and analyze different types of radar systems.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	To know the basic building blocks of a radar system.	Familiarity
CO-2	To have an in-depth knowledge on different types of signals that are used in radar systems.	Familiarity
CO-3	To know about the ambiguity function and its significance in radar signal processing.	Assessment
CO-4	To know the principle of operation of sonar and sound propagation in water.	Assessment
CO-5	To apply the knowledge acquired in this course in real time applications.	Usage

Course Contents:

Unit	Contents	Lectures required
1	Introduction: Introduction to radar and radar equation, radar wave propagation. Radar block diagram, resolutions in range velocity, radar equation, types of radars. Atmospheric effects on radar wave propagation. Radar cross section, radar displays.	6
2	CW,FM and MTI radar systems: Doppler radar, CW radar, FMCW radar, multiple frequencies CW radar, MTI radar, delay line cancellers, staggered pulse repetitive frequencies, pulse Doppler radar, limitations of MTI radar.	8
3	Radar waveforms: Matched filter, Pulse compression, ambiguity function, LFMCW, HFM waveforms, Doppler invariant waveforms.	8
4	Radar antennas and radar tracking: Radar antennas and radar tracking Antenna basics, antenna arrays, analysis and synthesis of antenna arrays. Buttler's matrix, tracking of radar. Synthetic aperture radar.	9
5	Radar transmitters and receivers: Noise figure, amplifiers, mixers, power dividers and phase shifters.	8
6	Introduction to sonar: Under water propagation, types of sonar, sonar transducers.	3
Total lectures		42

Suggested Text Book(s):

1. Peebles, Peyton Z. "Radar principles" ,Wiley India Edition, John Wiley & Sons, 2007.
2. Skolnik, Merrill I. " Introduction to radar systems", 3rd Edition, McGraw-Hill Education,2002.
3. Elliot, Robert S. "Antenna theory and design", Wiley India Edition, John Wiley & Sons, 2007.
4. Lawrence J.Ziomek, "An introduction to Sonar Systems Engineering", 1st Edition, CRC Press,2017.

Suggested Reference Book(s):

1. Stutzman, Warren L., and Gary A. Thiele. "Antenna theory and design", Wiley India Edition, John Wiley & Sons, 2012.

2. Pozar, David M. “Microwave engineering”, 4th Edition, John Wiley & Sons, 2013.
3. Cheng, David Keun. “Field and wave electromagnetics”, 2nd Edition, Pearson Education India, 1989.
4. Mark. A Richards, “Fundamentals of Radar Signal Processing”, 2nd Edition, McGraw-Hill Professional Engineering, 2014.

Other useful resource(s):

1. Link to NPTEL course contents:https://nptel.ac.in/courses/101108056/
2. Link to topics related to course:
   https://nptel.ac.in/courses/101108056/1 to 7
   https://ocw.mit.edu/resources/res-ll-001-introduction-to-radar-systems-spring-2007/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Radar Principles and Applications)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	2	1	1	1	2	1	2	1.5
CO-2	2	3	2	3	2	2	1	1	1	2	1	2	1.6
CO-3	3	3	3	3	3	2	1	1	1	2	1	2	1.8
CO-4	2	2	2	2	2	2	1	1	1	3	1	2	1.5
CO-5	3	2	3	2	2	2	1	1	1	2	1	2	1.6
Average	2.4	2.4	2.4	2.4	2.2	2.0	1.0	1.0	1.0	2.2	1.0	2.0	

Industrial Automation and Control

COURSE CODE: 18B1WEC840

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Electrical Networks, Control Systems

Course Objectives:

1. Overall exposure to the technology of Industrial Automation and Control as widely seen in factories of all types both for discrete and continuous manufacturing.
2. To explain the general architecture of Industrial Automation Systems and develop automation systems using PLC programming.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Students will be able to handle any kind of process by framing it in block diagram, mathematical model and different process variables.	Familiarity
CO-2	Students will be able to handle different types of controller like electronic, pneumatic and hydraulic.	Assessment
CO-3	Understand principle of working of various signal conditioners used with Temperature, Displacement, Optical and various miscellaneous other sensors.	Assessment
CO-4	Students will be able to implement different control schemes to various processes.	Assessment
CO-5	Students will be able to design relay logic for various processes.	Usage

Course Contents:

Unit	Contents	Lectures required
1	Introduction to industrial automation and Control, Architecture of industrial automation systems	2
2	Sensors and Measurement Systems: Temperature measurement; Pressure and force measurements; Displacement and speed measurement; Flow measurement techniques; Measurement of level, humidity, pH etc	8
3	Signal conditioning and processing; Estimation of errors and calibration	4
4	Motion Actuators: Types of motion and motion conversion, Electric linear actuators, Electric rotary actuators, Fluid-power linear actuators, Fluid-power rotating actuators	4
5	Process Control: PID control, Controller tuning, Implementation of PID controllers, Special control structures : Feed-forward and ratio control, Predictive control, Cascade control, Overriding control, Selective control, Split rangecontrol	8
6	Sequence Control, PLCs and Relay Ladder Logic: Scan cycle, RLL syntax; Structured design approach; Advanced RLL programming; Hardware environment	8
7	Robotics and Numerical Control : Basic robot definitions, Basic manipulator configurations, Numerical control systems, Robot kinematics, Robot grippers, Robot sensors, Robot programming, General considerations for robot applications	8
Total lectures		42

Suggested Text Book(s):

1. S. Mukhopadhyay, S. Sen and A. K. Deb, "Industrial Instrumentation, Control and Automation", Jaico

Publishing House, 2013.
2. George Stephanopoulos, "Chemical Process Control: An Introduction to Theory and Practice", 1st edition, Prentice Hall India, 2012.

Suggested Reference Book(s):

1. R. Krishnan, "Electric Motor Drives, Modelling, Analysis and Control", Prentice Hall India, 2002.
2. Herbert E. Merritt, "Hydraulic Control Systems", Wiley, 1991.

Other useful resource(s):

1. Link to NPTEL course contents: https://nptel.ac.in/courses/108105062/
2. Link to SWAYAM course contents: https://swayam.gov.in/course/4440-industrial-automation-and-control

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignments (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Industrial Automation and Control)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	2	2	2	2	2	1	1	2	3	3	2
CO-2	3	3	3	2	3	2	2	1	1	2	3	3	2.2
CO-3	3	3	3	3	3	3	3	1	3	3	3	3	2.8
CO-4	3	3	3	3	3	3	3	1	3	3	3	3	2.8
CO-5	3	3	3	3	3	3	3	1	3	3	3	3	2.8
Average	3	3	2.8	2.6	2.8	2.6	2	1	2.2	5	3	3	

Bio Electronic Sensors

COURSE CODE: 18B1WEC841

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

1. To learn about transducers, bio-sensors, bio-potentials electrodes and bio-signal amplifiers.
2. To understand the various bio-potentials generated in human body and the instrumentation used to acquire it.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Gain knowledge on sensors, actuators and transducers	Familiarity
CO-2	Learn to design circuits of bio-sensor for electrical and nonelectrical signals	Usage
CO-3	Acquaint with different types of amplifiers used for biosensors	Familiarity
CO-4	Learn about bio-potential and bio-potential amplifiers	Assessment

Course Contents:

Unit	Contents	Lectures required
1	Introduction: Introduction to Sensor, Bio electronics, Bioelectronics Sensor, Systems biology and Synthetic biology	4
2	Electrodes, Sensors and transducers: Sensor/Actuators, Active v/s passive sensors, sensor error sources, sensor terminology, Types of Sensors, Bio sensor, Block diagram of Bio-sensor for electrical and non electrical signals, electrodes for biophysical sensing, transducers, performance parameters of sensors, complete circuit diagram of bio sensor.	8
3	Bio-potential Electrodes: The electrode-electrolyte interface, polarization, polarizable and non-polarizable electrodes, Electrode behavior and circuit models, body surface recording electrodes, internal electrodes, micro electrode, macro electrode	4
4	Bio-electric Amplifiers: Voltage, current, power amplifiers, Low gain, medium gain, high gain amplifiers	6
5	Bio-potentials: ECG, EEG, EMG, ERG, EOG, its amplitude and bandwidth, Electrodes for Bio-potential Recordings, Electrical Interference Reduction.	6
6	Bio-potential Amplifiers: Operational amplifiers, basic amplifier configurations, multiple input circuits, differential amplifiers, signal processing circuits, isolation amplifiers, IMRR, ECG Amplifier, functional block, interference from electric devices, transient protection, common mode and other interference reduction circuits, Driven right leg circuit, amplifiers for other bio-potential signals, pre amplifier.	8
7	Bio-signal Amplifiers : Instrumentation amplifier, Chopper Amplifier, Carrier Amplifier	6
Total lectures		42

Suggested Text Book(s):

1. Carr, J.J., Brown, J.M., "Introduction to Biomedical Equipment Technology," 4th Ed., Pearson, 2001.
5. Reddy, D.D., Hussian, O.M., Gopal, D.V. R., Rao, D. M., Sastry, K.S. "Biosensors and Bioelectronics," I.K. International Pub., 2012

Suggested Reference Book(s):

1. Webster JG (Ed.), "Medical Instrumentation, Application and Design," 4th Ed., John Wiley & Sons, 2016.
2. Chatterjee S and Miller A, "Biomedical Instrumentation Systems," Cengage Learning, 2018.
3. Gayakwad, R. A., "Op-amps and Linear Integarted Circuits," 4th Ed., PHI, 2000.

Other useful resource(s):

NPTEL Online Courses: Biomedical Signal Processing - https://nptel.ac.in/courses/108105101/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered up to T-1
2	T-2	25	1.5 Hours	Syllabus covered up to T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

CO/PO (Bio electronic Sensor)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO1	3	3	2	1	1	2	X	X	X	X	X	2	1.17
CO2	3	3	3	2	2	2	X	X	1	2	2	3	1.92
CO3	3	3	2	1	1	2	X	X	X	1	1	3	1.42
CO4	3	3	2	2	1	2	X	X	X	1	1	3	1.50
Average	3.00	3.00	2.25	1.50	1.25	2.00	0.00	0.00	0.25	1.00	1.00	2.75	

Optical Networks

COURSE CODE: 18B1WEC842

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Mathematical Physics

Course Objectives:

1. To expose the students to the basics of signal propagation through optical fibers, fiber impairments, components and devices and system design.
2. To make the students aware of the hardware used for practical purposes.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Recognize and classify the structures of Optical fiber and types.	Familiarity
CO-2	Discuss single hop and multihop fibers.	Assessment
CO-3	Analyze various coupling losses.	Assessment
CO-4	Get acquainted with optical switching.	Usage
CO-5	Get familiar with the recent optical networks used for practical purposes.	Usage

Course Contents:

Unit	Contents	Lectures required
1	Optical Networking-Introduction and Challenges: Advantages of optical network, telecom network overview and architecture, WDM optical networks, WDM network evolution, WDM network construction, broadcast and select optical WDM network, wavelength routed optical WDM network.	7
2	Optical Networking Components/Building Blocks : Optical transmitters, semiconductor laser diode, tunable and fixed laser, laser characteristics, photodectors, tunable and fixed optical filters, channel equalizers, optical amplifiers and its characteristics, semiconductor laser amplifier, Raman amplifier, doped fiber amplifier, various switching elements.	8
3	Single and Multi-hop Networks: Introduction to single and multi-hop networks, Characteristics of single and multi-hop networks, experimental single hop networks: LAMBDANET, STARNET, SONATA, Rainbow, experimental multi-hop networks: Shufflenet, De Bruijn Graph, Hypercube.	8
4	Optical switching: Optical packet switching basics, slotted and unslotted networks, header and packet format, contention resolution in OPS networks, self routing, examples on OPS node architecture.	8
5	Optical Access and Metro Network: Introduction to access network, PON, EPON and WDN EPON: overview, principal of operation, architecture; dynamic wavelength allocation, STARGATE: overview, need, architecture, operation and application, gigabit Ethernet, radio over fiber network. Introduction to metro network, overview of traffic grooming in SONET ring, traffic grooming in WDM ring, Interconnected WDM networks, packet communication using tunable WADM.	11
Total lectures		42

Suggested Text Book(s):

1. Optical Network Series:Biswanath Mukherjee, Springer, 2006.
2. Optical Networks: R.Ramaswami and K.Sivarajan, Â Morgan Kaufmann Publishers, 2nd Edition, 2002.
3. Optical Switching Networks: Mayer & Martin, Cambridge University Press, 2008.
4. Optical Fiber Communications- Principles and Practice by John M Senior, 3rd Edition, Pearson Education India.

Suggested Reference Book(s):

1. Data Communication by Behrouz Â, A Forouzan, Mc Graw Hill, 4th Edition.
2. Optical Switching: Tarek S. El. Bawab, Springer.

Other useful resource(s):

1. http://www.iec.org/online/tutorials/acrobat/opt_net.pdf
2. http://www.pdf-search-engine.com/optical-networking-pdf.html
3. http://www.networktutorials.info/networkhowto/what_is_optical_networking.html
4. http://www.urec.fr/hd/DWDM/ALCATEL/optical_network.pdf

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes(2) -10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Optical Networks)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	1.75
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	2
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	1.75
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	2.08
CO-5	2	3	3	3	2	1	1	1	2	3	2	2	2.08
Average	2	2.6	2.6	2.6	2.4	1	1	1	2	2.4	1.6	2	

Interpersonal Dynamics, Values and Ethics

COURSE CODE: 18B11HS311

COURSE CREDITS: 3

CORE/ELECTIVE: CORE

: 3-0-0

Pre-requisite: None

Course Objectives:

1. This course is designed to help students understand the importance of values in their development as professionals and responsible citizens.
2. This starts with developing an understanding of their own needs and wants, what they 'really want to be' in their lives and profession.
3. This understanding of oneself then leads to understanding others better so that effective personal and professional relationships can be built.
4. The moment a student enters the workplace they are confronted with organizational values and ethical dilemma.
5. This course helps facilitate the students to understand harmony at all the levels of human living, and live an ethical and happy life.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Understand the significance of value inputs in a classroom and learn their significance in personal and professional life.	Familiarity
CO-2	Appreciate the relationship between values and skills, happiness and accumulation of physical facilities, the Self and the Body, Intention and Competence of an individual, etc.	Assessment
CO-3	Understand the value of harmonious relationship based on trust and respect in their life and profession.	Assessment
CO-4	Understand the role of a human being in ensuring harmony in society and nature.	Usage
CO-5	Distinguish between ethical and unethical practices, and start working out the strategy to actualize a harmonious environment wherever they work.	Usage

Course Contents:

Unit	Contents	Lectures required
1	**Human Values:** Definition and classification of values: Extrinsic values, Universal and Situational values, Physical, Environmental, Sensuous, Economic, Social, Aesthetic, Moral and Religious values. The Problem of Sustenance of value in the process of Social, Political and technological change. Case Study 3 The Three Mile Island Disaster	5
2	**Understanding Individual Differences, perceptions and attributions:** Understanding and Managing Yourself: Human Relations and You: Self- Esteem and Self-Confidence: Self-Motivation and Goal Setting; Emotional Intelligence,	5

	Attitudes and Happiness; Problem Solving and Creativity.	
3	**Leadership and Motivation:** Dealing Effectively with People: Communication in the Workplace, Becoming an Effective Leader; Motivating Others and Developing Teamwork	**5**
4	**Developing and leading teams** Tactics for Getting Along with Others in the Workplace; Managing Conflict; Specialized Diversity and Cross-Cultural Competence.	**4**
5	**Interpersonal Dynamics in practice** Self confidence and attitude building, Social and Professional etiquettes (To be conducted on workshop mode with the help of role plays, GDs, self and peer appraisal and class demonstrations. Performance to be evaluated for internal assessment)	**6**
6	**Engineering Ethics** History, Recent developments and General principles. Case Study 1 Space Shuttle Challenger	**4**
7	**Engineering as Social Experimentation** Engineer as experimenter, Responsibility in experimentation	**3**
8	**Engineers' Responsibility for Safety and Risk** Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis	**4**
	and Reducing Risk – Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights – Intellectual Property Rights (IPR) – Discrimination Case Study 2 Bhopal Gas Tragedy	
9	**Global Issues** Multinational Corporations – Environmental Ethics – Computer Ethics – Weapons Development – Engineers as Managers – Consulting Engineers – Engineers as Expert Witnesses and Advisors – Moral Leadership –Code of Conduct – Corporate Social Responsibility Case Study 4 The Chernobyl Disaster	**4**
10	**Ethical Audit :** Need for and ethics audit, Procedure, Best practices	**2**
Total lectures		**42**

Suggested Text Book(s):

1. Govindarajan M, Natarajan S, Senthil Kumar V. S: Professional Ethics and Human Values, Prentice Hall of India, 2016.
2. R R Gaur, R Sangal, G P Bagaria: Human Values and Professional Ethics, Excel Books, 2010.
3. Stephen P. Robbins, Timothy A. Judge: Organizational Behavior, 15th Edition, Pearson Education, 2015

Suggested Reference Book(s):

1. Ken Blanchard, Spencer Johnson, The New One-Minute Manager, HarperCollins Publishers Limited, 2015

Other useful resource(s):

1. Institution of Engineers (India): Sample Codes of Ethics
2. ACM Code of Ethics and Professional Conduct
3. Websites related to course:
   i. www.onlineethics.org
   ii. www.nspe.org
   iii. www.globalethics.org
   iv. www.ethics.org

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Class participation in case discussion and group discussions (2) - 10 Assignments (2)- 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme outcomes (POs)

Course outcomes (Interpersonal Dynamics, Values and Ethics)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	0	2	2	2	1	3	2	3	3	3	0	3	2.4
CO-2	0	2	2	2	1	3	2	3	3	3	0	3	2.4
CO-3	0	2	2	2	0	3	2	3	3	3	0	3	2.3
CO-4	0	2	2	2	1	3	2	3	3	3	0	3	2.4
CO-5	0	2	2	2	1	3	2	3	3	3	0	3	2.4
Average	0	2	2	2	2	3	2	3	3	3	0	3	

Industrial Enzymes Technologies

COURSE CODE: 18B1WBT733

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Enzyme production purification and applications

Course Objectives:

1. The objective of the course is to develop an understanding of important aspects of production and purification of industrially important enzyme and their application in industry.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	To develop an understanding of basic concepts of enzymes.	Familiarity
CO-2	To understand the basic mechanism of action and working behaviour of enzymes	Assessment
CO-3	To familiarize the students with various applications of enzymes in laboratory as well as Industrial scale.	Assessment
CO-4	To conceptualize about immobilized enzyme technology, and other specific enzymes and their applications.	Usage
CO-5	To familiarize the students with present potential of enzyme in industrial application and improved activity of the enzyme using various molecular biology techniques.	Usage
CO-6	To understand the principle and function of enzyme in various adverse conditions like high temperature and pH(s).	Assessment

Course Contents:

Unit	Contents	Lectures required
	Enzymes: Basic concepts: Enzymes as powerful and highly specific catalysts, Classification of enzymes, free energy and enzymes, the formation of the transition state, catalytic strategies. General properties:	**5**

1	Enzyme specificity, stability and structure, Factors affecting enzyme activity; effect of pH and Temperature, Substrate and Enzyme concentration.	
2	**Enzyme kinetics**: Michaelis-Menten kinetics, evaluation of parameters in the Michaelis-Menten equation, 3-D structure of active site, Kinetics of single and bi-substrate enzyme catalysed reactions, Inhibition & its kinetics.	**5**
3	**Enzyme preparation techniques:** Sources of enzymes, production,Recovery and purification of intracellular products: cell disruption, chromatographic techniques. Analytical assays of purity level of enzymes.	**3**
4	**Enzyme preparation and application in industries:** Application of enzymes in leather, glucose syrup production, starch and sugar industry, Dairy and food industry, Beverage industry, Textile industry. Hydrolysis of starch and cellulose. Catalytic functions of Cellulase, lipase, esterase laccase amylase, glucose isomerase, protease, xylanase, invertase, peroxidises. Other applications of enzymes in solution: medical applications of enzymes, non-hydrolytic enzymes in current and developing industrial technology.	**10**
5	**Enzyme engineering:** Mechanisms and manifestations of protein denaturation. Strategies for enzyme stabilization: Physical and chemical modifications, Selection, directed evolution and Rational design. design and construction of mutant enzymes, Bifunctional and polyfunctional enzyme, Enzyme in organic solvents.	**5**
6	**Immobilized-enzyme technology**: Introduction, enzyme immobilization method: Entrapment, carrier-binding and cross-linking method. Medical and analytical applications of immobilized enzymes.	**8**
7	**Specified Enzymes and applications:** Thermozymes, Cold adapted enzymes, Ribozymes, Hybrid enzymes, Diagnostic enzymes, Therapeutic enzymes: Characteristics, principles and applications.	6
Total Lectures		**42**

Suggested Text Book(s):

1. Devasena, T., "Enzymology", 1st ed., Oxford University Press, 2010
2. Berg, J.M., Tymoczko, J.L. and Stryer, L., "Biochemistry", 5th ed., W.H. Freeman and Company, New York, 2002.
3. Nelson D.L., Cox M.M., "Lehninger Principles of Biochemistry", 5th ed., W.H. Freeman and Company, New York, 2008.

Suggested Reference Book(s):

1. Pye, E.K. and Wingard, L.B., "Enzyme Engineering II", Plenum Press, 1974.
2. Illanes A, "Enzyme Biocatalysis", Springer Science, 2008.

Other useful resource(s):

https://nptel.ac.in/course.php?disciplineId=102

EvaluationScheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment, Quizzes&Attendance

Course Outcomes (COs) contribution to the ProgrammeOutcomes(POs)

Course outcomes (Industrial Enzymes)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	3	1	1	2	2	3	2	2	1	2	1.9
CO-2	1	2	2	2	2	1	-	2	2	2	1	3	1.8
CO-3	2	2	2	2	2	2	1	1	2	-	2	2	1.8
CO-4	2	3	2	1	2	1	-	1	3	2	-	2	1.9
CO-5	1	3	1	3	2	2	1	2	1	2	1	3	1.8
CO-6	1	1	-	2	2	2	2	1	2	2	1	3	1.7
Average	1.5	2.1	1.6	1.8	1.8	1.6	1	1.6	2	2	1.2	2.5	

Department of Biotechnology & Bioinformatics

Intellectual Property Rights and Commercialization

COURSE CODE: 18B1WBT732

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE L-T-P:

3-0-0

Pre-requisite: None

Course Objectives:

1. To provide an insight and understanding about different aspects of protection of inventions and research developments
2. Learn about procedures for filling protection through Intellectual Property Rights.
3. **To provide scopes of protection of diverse intellectual properties and its commercialization for socio-economic improvement.**

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	To enable students with basic concepts and knowledge of intellectual property rights.	Awarness
CO-2	To apply and execute different types of IP protection in research and academics.	Assessment and technical skills
CO-3	Able to understand about the mechanisms of different IP protections, registrations and applications	Technical
CO-4	To be capable of tackling issues related to IP and its commercialization	Assessment
CO-5	Able to learn the strategies for effective IP management and commercialization	Analytical skills
CO-6	To apply the knowledge of IPR for the benefit generation and for mass utilization	Usage

Course Contents:

Unit	Contents	Lectures required
1	**Introduction**:Introduction of Intellectual properties and rights conferred . Integration of Intellectual Property, Bioethics and Biosafety for biological and applied sciences in research and academia.	4
2	**Types of IP tools**:Different types of IPR(Patents, copyrights and related rights, Trademark, Tradesecret, Integrated circuit layout, Geographical indications, Traditional knowledge, Industrial designs and PBR)Drafting Patent Application and Documentation Revocation of Patent, Litigation and Infringement Rationale of different IPR ,their mechanism of protection and provisions in Law	10
3	**International Agreements** and Treaties:International IP treaties (Madrid Agreement, Trademark law treaty, Patent Law treaty etc.) WIPO, EPC, WTO, and TRIPS. International agreements relevant to biotechnology-associated IP	8
4	**Commercialization**: Methods commercialization. Financing of commercialization,Impact of	6
5	**IP Management for value addition:** Strategies for IP Management and	

	commercialization. IP audit, IP insurance Bioentreprenuership management	4
6	**Licensing/Assignment** :Types of licensing and modes to carry out, Assignments and its benefits, Compulsory Licensing Commercialization for social and economic prosperity with case studies	8
Total lectures		**42**

Suggested Text Book(s):

1. Intellectual Property Rights & Copyright By Bouchoux.
2. Intellectual Property Licensing Strategies by Thompson Reuters

Suggested Reference Book(s):

1. Intellectual Property Rights, the WTO and Developing Countries: The TRIPS ...Book by Carlos María Correa
2. Perspectives on Commercializing Innovation by F. Scott Kieff (Editor), Troy A. Paredes (Editor

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Intellectual Property Rights & Commercialization)	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**Average**
CO-1	2	2	2	2	2	1	1	1	1	1	2	2	**15**
CO-2	2	2	1	2	2	2	1	1	1	1	1	2	**1.5**
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	**1.7**
CO-4	2	2	3	3	2	1	1	1	2	2	2	2	**1.9**
CO-5	2	2	2	2	2	1	2	1	1	2	1	2	**1.6**
CO-6	2	2	2	2	2	2	1	1	2	2	2	2	**1.8**
Average	**3.4**	**3.4**	**2**	**2.1**	**2.1**	**1.3**	**1.1**	**1**	**1.5**	**1.6**	**1.5**	**2**	

Industrial Enzyme Technology

COURSE CODE

COURSE CREDITS: 3

CORE/ELECTIVE:

L-T-P: 3-0-0

Pre-requisite: Enzyme screening production purification and applications

Course Objectives

1. The objective of the course is to develop an understanding of important aspects of production and purification of industrially important enzyme and their application in industry.

Course Outcomes

Sr. No.	Course outcomes	Level Attainment
CO I	To develop an understanding of basic concepts of enzymes.	Familiarity
CO II	To understand the basic mechanism of action and working behaviour of enzymes	Familiarity
CO III	To familiarize the students with various applications of enzymes in laboratory as well as Industrial scale.	Assessment
CO IV	To conceptualize about immobilized enzyme technology, and other specific enzymes and their applications.	Assessment
CO V	To familiarize the students with present potential of enzyme in industrial application and improved activity of the enzyme using various molecular biology techniques.	Usage
COVI	To understand the principle and function of enzyme in various adverse conditions like high temperature and pH(s).	Usage

Topic Covered

S. No.	Contents	Contact Hrs.
1	**Enzymes: Basic concepts** **Introduction** and classification of enzymes, free energy and enzymes, the formation of the transition state, catalytic strategies. **Properties of enzymes**: Enzyme specificity, stability and structure, Factors affecting enzyme activity; effect of pH and Temperature, Substrate and Enzyme concentration.	5
2	**Kinetics of enzymes** **Enzyme kinetics**: Michaelis-Menten kinetics, evaluation of parameters in the Michaelis-Menten equation, 3-D structure of active site, Kinetics of single and bi-substrate enzyme catalysed reactions, Inhibition & its kinetics.	5
3	**Production and purification techniques** **Enzyme preparation techniques**: Sources of enzymes, production, Recovery and purification of intracellular products: cell disruption, chromatographic techniques. Analytical assays of purity level of enzymes.	5

4	**Preparation, Quantification and Industrial applications** **Application of enzymes**: In leather, glucose syrup production, starch and sugar industry, Dairy and food industry, Beverage industry, Textile industry. Industrial enzymes: Cellulase, lipase, esterase laccase amylase, glucose isomerase, protease, xylanase, invertase, peroxidises. Other applications of enzymes in solution: medical applications of enzymes, non-hydrolytic enzymes in current and developing industrial technology.	8
5	**Enzymes: molecular engineering** **Enzyme engineering:** Mechanisms and manifestations of protein denaturation. Strategies for enzyme stabilization: Physical and chemical modifications, Selection, directed evolution and Rational design. Design and construction of mutant enzymes, Enzyme in organic solvents.	5
6	**Immobilization of enzymes using various techniques** **Immobilized-enzyme technology:** Introduction, enzyme immobilization method: Entrapment, carrier-binding and cross-linking method. Medical and analytical applications of immobilized enzymes.	8
7	**Specified Enzymes and applications** Thermozymes, Cold adapted enzymes, Ribozymes, Hybrid enzymes, Diagnostic enzymes, Therapeutic enzymes: Characteristics, principles and applications.	6
	Total Number of Lectures	**42**

REFERENCE & TEXT BOOKS

1. Industrial Biotechnology: Sustainable Growth and Economic Success by Soetaert and Erick J. Vandamme
2. Fermentation and Biochemical Engineering Hand Book by HC Vogel
3. Industrial Biotechnology by J. Thompson
4. Industrial Biotechnology by AS Maturiya
5. Industrial Biotechnology by IS Thakur
6. Review articles from Science Direct, Springer, Wiley and PubMed Publishers

Evaluation Scheme:

Assessment	Max. marks	Duration	Course Covered
T1 Test	15	1 hr.	Syllabus covered upto T-1
T2 Test	25	1.5 hrs.	Syllabus covered upto T-2
End Term Test	35	2 hrs.	Entire Syllabus
Teacher Assessment	25	Entire Sem	Based on Assignments, quizzes etc.

Information Systems

COURSE CODE: 18B11CI512

COURSE CREDITS: 3

CORE/ELECTIVE: CORE

L-T-P-: 3-0-0

Pre-requisite: Java Programming

Course Objectives:

1. Understand various technologies and processes available for developing business software.
2. Study and understand underlying infrastructure of information systems.
3. Learn to identify and analyze requirements for information systems
4. Develop proficiency in structuring, collecting, and analyzing data to support business operations and strategic decision making.
5. Understand and apply design principles in Information Systems
6. Demonstrate proficiency in selecting, implementing and operating information technology solutions to meet organizational requirements.
7. Develop an understanding of the social issues and ethical implications of technology across organizations and society.
8. Develop a proficiency in the selection of tools, techniques, processes, and success factors related to effective management of IT projects.
9. Develop proficiency in business reporting and strategic analysis of data..

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	To understand the fundamental terms and concepts of information systems, associated technologies and underlying infrastructure.	Familiarity
CO-2	To understand how IT provides value by improving the management process through access to better information.	Familiarity
CO-3	To acquire knowledge and develop hands on skills on various information system development technologies.	Usage and Assessment
CO-4	To understand and analyze information system categories along with their principles and design issues.	Familiarity and Assessment
CO-5	To understand and analyze the social issues and ethical implications of technology across organizations and society.	Familiarity and Assessment
CO-6	To develop the ability to evaluate information systems, assess user needs, propose solutions, and evaluate proposals for implementation.	Assessment

Course Contents:

Unit	Contents	Lectures required
1	Introduction to Information Systems, Concept and characteristics of information, Essential aspects of information systems in a company, Information technology,	**4**
2	Architectural components of information systems, MVC approach to building Information Systems	**2**
3	Information system development technologies, Java Servlets, Java Server pages, Session Management, Enterprise Java Beans, Enterprise Computing, Java cryptography Architecture.	**8**
4	Information System categories • Transaction Processing Systems (TPS) • Management Information System (MIS) • Decision Support Systems (DSS): Problem resolution with DSS, Possibilities of DSS, Use of spreadsheets as decision-making support systems, Using DSS in decision making process, • Executive Information Systems (EIS): Evolution, EIS concepts and categories	**12**
5	Information System categories Specification: • design issues and principles • User interface design; demonstrating good UI design principles; • Contemporary Information Systems Architectures; • Contemporary information system development tools, components and techniques; • Specific documents and other analysis and design artifacts	**4**
6	Prototype demonstration Contemporary Issues In Information Systems: Internet mediated communication, Three dimensional communities, Collaboration and digital natives,	**4**
7	Crowd Sourcing, E-Governance, E-Commerce and location based services, Gender and cyber behaviour, Ethics of building Information Systems	**4**

8	Introduction to Information Security: What is security approaches to information security implementation, The Security Systems Development Life Cycle, Different types of threats and attacks.	**4**
Total Lectures		**42**

Suggested Text Book(s):

1. Rafael L. Alcami, Carlos D. Caranana, "Introduction to Management Information Systems".
2. Marty Hall, Larry Brown, "Core Servlets and Java Server Pages", Prentice Hall
3. Whitman, M.E. and Mattord, H.J., 2011. Principles of information security. Cengage Learning.

Suggested Reference Book(s):

1. Ethan Cerami, "Web Services Essentials", O'Reilly
2. Kogent, "Java Server Programming tutorial, J2EE Black Book", Dreamtech Press
3. Herbert Schildt, "The Complete Reference: JAVA", Tata McGraw- Hill
4. Kathy Sierra & Bert Bates, "Head First EJB", O'Reilly
5. Phil Hanna, "The Complete Reference: JSP 2.0" Tata McGraw-Hill
6. Stefan B. Harsh, "Management Information Systems"

Other useful resource(s):

1. Link to NPTEL course contents: https://nptel.ac.in/courses/122105022/
2. Link to topics related to course:
3. https://www.coursera.org/learn/information-security-data
4. https://www.journaldev.com/2114/servlet-jsp-tutorial
5. https://www.javatpoint.com/servlet-tutorial
6. http://www.springer.com/business+%26+management/business+information+systems/journal/10796
7. http://www.irma-international.org/journal/international-journal-enterprise-information-systems/1086/
8. https://www.journaldev.com/1854/java-web-application-tutorial-for-beginners
9. https://www.udemy.com/javawebtut/

EvaluationScheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 9 Quizzes(2) -12 Attendance - 4

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Information Systems)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	2	2	1	2	3	3	2	1	3	2	1	**2.1**
CO-2	3	3	2	1	1	3	3	1	3	3	3	1	**2.3**
CO-3	3	3	2	1	2	2	2	1	2	3	3	2	**2.2**
CO-4	3	3	3	2	2	2	3	2	2	1	2	2	**2.3**
CO-5	3	3	2	1	1	3	3	3	3	3	1	1	**2.3**
CO-6	3	2	2	1	2	2	2	2	1	2	1	2	**1.8**
Average	**3**	**2.7**	**2.2**	**1.2**	**1.7**	**2.5**	**2.7**	**1.8**	**2**	**2.5**	**2**	**1.5**	

Introduction to IPR

COURSE CODE:**18MS1BT116.**

COURSE CREDITS: 3

CORE/ELECTIVE: CORE

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

1. To provide an insight and understanding about intellectual properties and rights
2. Learn about procedures and methodologies for filling intellectual property protection
3. Learn strategies to use IPR for mass utilization.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	To enable students with basic concepts and knowledge of intellectual property rights.	Awarness
CO-2	Able to apply and execute different principles of bioethics and biosafety used in development of biotechnological products	Assessment and technical skills
CO-3	Able to understand about the mechanisms of different IP protections, registrations and applications	Technical
CO-4	To be capable of tackling all issues related to IP and commercialization	Assessment
CO-5	Able to learn the strategies for effective IP management	Analytical skills
CO-6	To apply the knowledge of IPR for the benefit generation and for mass utilization	Usage

Course Contents:

Unit	Contents	Lectures required
1	**OVERVIEW OF INTELLECTUAL PROPERTY**: Introduction of Intellectual properties and rights conferred .IPR in India and abroad.	4
2	**IP tools**: Different types of IPR(Patents, copyrights and related rights, Trademark, Tradesecret, Integrated circuit layout, Geographical indications, Traditional knowledge, Industrial designs and PBR). Rationale of different IPR ,their mechanism of protection and provisions in Law for registration and maintenance Copyright and related Rights Trademark protection and registration Industrial design protection Geographical Indications New Plant Varieties Unfair competition	10
3.	**PATENT**: Patent and kind of inventions protected by a patent Patent document How to protect your inventions? Granting of patent Rights of a patent How extensive is patent protection? Why protect inventions by patents? Searching a patent Drafting of a patent Filing of a patent . Drafting Patent Application and Documentation Revocation of Patent, Litigation and Infringement	4
4	**International Agreements** and Treaties: International IP treaties (Madrid Agreement, Trademark law treaty, Patent Law treaty etc.) WIPO WTO, and TRIPS. International agreements relevant to biotechnology-associated IP	8

5.	**ENFORCEMENT OF INTELLECTUAL PROPERTY RIGHTS:** Infringement of intellectual property rights Enforcement Measures Emerging issues in Biological sciences	4
6	**INTELLECTUAL PROPERTY rights and role in Biotechnology** **Overview of Biotechnology** procedures and product development for IP protection Biotechnology Research and role of bioethics and biosafety for safe product development. Case studies of Biotechnological products and others	6
7.	**IP Management** and Commercialization Strategies for management and bioentrepreneurship	4
Total lectures		**42**

Methodology

The course will be covered through lectures, presentations and videos. Apart from discussions on topics covered through lectures and assignments, students have to carry out research paper analysis.

Suggested Text Book(s):

1. Intellectual Property Rights & Copyright By Bouchoux.
2. IPR, Biosafety and Bioethics Book by Deepa Goel and Shomini Parashar
3. T. M Murray and M.J. Mehlman,Encyclopedia of Ethical, Legal and Policy issues in Biotechnology, John Wiley & Sons 2000

Suggested Reference Book(s):

1. Intellectual Property Rights, the WTO and Developing Countries: The TRIPS ...Book by Carlos María Correa
2. Bioethics and Biosafety by M K Sateesh.

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus

4.	Teaching Assessment	25	Entire Semester	Assignment, Quizzes & Attendance

Machine Learning and Data Analytics–I

COURSE CODE: 18B1WEC733

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Introduction to programming, Data Structure and Probability theory

Course Objectives:

1. To provide a broad survey of approaches and techniques in machine learning;
2. To develop a deeper understanding of several major topics in machine learning;
3. To develop the design and programming skills that will help you to build intelligent, adaptive artifacts.
4. To develop the basic skills necessary to pursue research in machine learning.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Understand the basic theory underlying machine learning.	Familiarity
CO-2	Understand a range of machine learning algorithms along with their strengths and weaknesses.	Usage
CO-3	Apply machine learning algorithms to solve problems of moderate complexity.	Assessment
CO-4	Formulate machine learning problems corresponding to different applications.	Assessment
CO-5	Read current research papers and understand the issues raised by current research.	Usage

Course Contents:

Unit	Contents	Lectures required
1	**Introduction:** Fixed, Adaptive and Intelligent systems; Adaptive techniques: Prediction, Classification, Forecasting, Filtering, Direct and Inverse modeling.	5
2	**Data Exploration and Pre-processing:** Data objects and attributes; Statistical measures, Visualization, Data cleaning and integration	5
3	**Dimensionality Reduction:** Discriminant analysis; Principal component analysis, Independent component analysis; Transform Domain and statistical feature extraction and reduction.	4
4	**Regression:** Linear regression, Multivariate regression, Logistic regression; Support vector machine.	6

5	**Clustering:** K-Means, Hierarchical and Density based clustering.	**7**
6	**Decision Tree based Learning:** Decision tree induction, Attribute selection and tree pruning.	**4**
7	**Artificial Neural Networks:** Single layer neural network, Multilayer Perceptron, Back Propagation learning, Functional link artificial neural network, Radial basis function network, Recurrent neural networks, Convolution neural network.	**11**
Total lectures		**42**

Suggested Text Book(s):

1. J. Watt, R. Borhani and A. K. Katsaggelos: Machine Learning Refined: Foundations, Algorithms and Applications, Cambridge University Press, 1st ed., 2016.
2. C. Bishop: Pattern Recognition and Machine Learning, Springer, 1st ed., 2006.
3. J. Han, M. Kamber, J. Pei: Data Mining: Concepts and Techniques, Elsevier Amsterdam, 3rd ed., 2011

Suggested Reference Book(s):

1. T. Hastie, R. Tibshirani, J. Friedman: The Elements of Statistical Learning: Data Mining, Inference, and Prediction, Springer, 2013.
2. H. Simon: Neural Networks and Learning Machines, Prentice Hall, 3rd ed., 2009.

Other useful resource(s):

1. H. Daume: A course in Machine Leaning, 2015. http://ciml.info/
2. Link to NPTEL course contents: Introduction to Machine Learning https://onlinecourses.nptel.ac.in/noc17_cs26/preview
3. Link to MITOPENCOURESEWARE: Machine Learning https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-867-machine-learning-fall-2006/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (3) - 10 Quizzes (3) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Machine Learning and Data Analytics–I)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	2	2	2	2	2	1	1	2	3	3	**2.17**
CO-2	3	3	3	2	3	2	2	1	1	2	3	3	**2.33**
CO-3	3	3	3	3	3	3	3	1	3	3	3	3	**2.83**
CO-4	3	3	3	3	3	3	3	1	3	3	3	3	**2.83**
CO-5	3	3	3	3	3	3	3	1	3	3	3	3	**2.83**
Average	**3.00**	**3.00**	**2.80**	**2.60**	**2.80**	**2.60**	**2.60**	**1.00**	**2.20**	**2.60**	**3.00**	**3.00**	

Microbial Ecology

COURSE CODE

COURSE CREDITS: 3

CORE/ELECTIVE: CORE

L-T-P: 3-0-0

Pre-requisite: Microbial populations diverse habitat and application

Course Objectives:

1. The course focus is on the structure and function of microbial communities, and current methods in microbial ecology.
2. The following subjects are studied: function and regulation of microbial productivity and metabolism; the importance of microbial processes for the turnover of nutrients and organic carbon; microbial interactions and co-evolution; molecular methods for species identification and quantification of microorganisms; biogeography, succession, and selection of bacteria.

Course Outcomes

Sr. No.	Course outcomes	Level Attainment
CO I	To understand basic concepts, history and overview of microbial ecology	Familiarity
CO II	To interpret the various ecological and evolutionary principles that impact microbes	Familiarity
CO III	To familiarize with experimental approaches used in the field of microbial ecology.	Assessment
CO IV	To understand basic methods and techniquesused in microbial ecology.	Usage
CO V	To gain knowledge about a specific aspect of the microbial ecology.	Usage
CO VI	To understand the applications of microbes growing in extreme environment for welfare of mankind	

Topic Covered

S. No.	Contents	Hrs
1	**Introduction to microbial ecology** **Introduction:** History, overview, definitions, terminology, concepts and applications	2
2	**Classification of microbial populations** **Physiological diversity of microorganisms**: prokaryotic diversity; eukaryotic microorganism; Microbial taxonomy, Phylogeny of *Archea*; **Extremophils:** commercial uses of extremophils; microbial diversity and its application in modern science	6
3	**Role of microorganism in ecosystem** **Individuals and populations**: productivity, growth, distribution, Ecology of macro- and microorganisms: Microbial functions in ecosystems and global cycles, Communities: colonization, succession, diversity, structure	8

4	**Methods in microbial ecology** **Methods**: Culture-based methods, biomarkers, cell stains, Characterization of microbial communities using PCR, real-time PCR, molecular fingerprints, FISH, sequencing, pyro-sequencing techniques		6
5	**Microbial interactions** **Interactions of microbes with environment**: Microbial guilds and biogeochemical cycles, **Interactions with the biotic environment**: symbiosis, competition, parasitism, predation. **Interactions within microbial communities**: Quorum sensing, syntrophy, antibiotics, Interactions of microorganisms with algae and plants, Interactions of microorganisms with animals and humans		8
6	**Microorganisms in Ecosystems** **Marine ecosystems**: deep-sea, methane seeps, anoxic basins, **Freshwater ecosystems**: lakes, rivers, swamps, bogs ocean surface, tidal flats, estuaries **Terrestrial ecosystems**: rocks and soil, prairie, forest, tundra ,		6
7.	**Applications of microbes in maintaining ecosystem**	**Extreme environments**: Deserts, hot springs, mine drainage, glaciers, deep subsurface, Landfills, **Microbial bioremediation:** wastewater treatment reactors, bioleaching, biodegradation, biomining, **Evolving communities:** evolutionary ecology and community stability	6
		Total Number of Lectures	**42**

REFERENCE & TEXT BOOKS

1. Microbial Diversity, D. Colwd
2. Microbial Ecology : Fundamentals and Applications 4th Edition
3. Microbial Ecology, Atlas and Bartha.
4. Microbial Ecology, J.M.Lynch and N. J. Poole
5. Microbial Ecology in Sustainable Agroecosystems (English, Hardcover, Diana H. Wall, Tanya Cheeke, Coleman David C. Prof.)
6. Human Microbial Ecology; Michael J. Hill (Author), Philip D. Marsh (Author)

Evaluation Scheme:

Assessment	Max. marks	Duration	Course Covered
T1 Test	15	1 hr.	Syllabus covered upto T-1
T2 Test	25	1.5 hrs.	Syllabus covered upto T-2
End Term Test	35	2 hrs.	Entire Syllabus
Teacher Assessment	25	Entire Sem	Based on Assignments, quizzes etc.

Microwave Components and Devices

COURSE CODE: 18B1WEC532

COURSE CREDITS: 3

CORE/ELECTIVE: CORE

L-T-P: 3-0-0

Pre-requisite: Electromagnetic Engineering

Course Objectives:

1. To learn the basic operating principles of microwave components.
2. To have a strong foundations in microwave measurements.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	To understand the basic knowledge of microwave sources.	Familiarity
CO-2	To have a complete knowledge about the wave guide components and their applications in microwave systems.	Assessment
CO-3	To understand and gain knowledge of different active devices and their working principles.	Familiarity
CO-4	To understand and gain thorough knowledge of microwave measurements.	Usage

Course Contents:

Unit	Contents	Lectures required
1	**Microwave Sources:** Microwave transmission lines, Klystron amplifier design and operation, reflex klystron and TWT amplifier and its gain calculations.	10
2	**Microwave waveguides:** Parallel plate wave guides, rectangular wave-guides, cylindrical wave-guides, resonators.	10
3	**Microwave components:** Directional coupler, E-plane Tee, H-plane Tee, Magic Tee, Microwave circulators, Microwave isolators, Microwave attenuators, microwave phase shifters, microwave impedance matching circuits.	10

4	**Microwave Devices:** Principles of microwave transistor, microwave FET, Gunn oscillators, IMPATT diode, TRAPATT Diode, BARITT diode, PIN diode, Tunnel diode.	**6**
5	**Network analysis and Microwave Measurements:** Power measurement, frequency measurement, impedance measurement and VSWR measurement. Scattering parameters and SFG models	**6**
Total lectures		**42**

Suggested Text Book(s):

1. Samuel Y.Liao, " Micro wave Devices and Circuits", 3rd edition, Pearson education,2003.
2. R.E.Collin, "Foundations for microwave Engineering", 2nd edition,Tata Mc Graw Hill,1992.

Suggested Reference Book(s):

1. Annapurna Das,Sisir.K.Das,"Microwave Engineering",Tata McGraw Hill, 2000.
2. Pozar, David M. "Microwave engineering" John Wiley & Sons,2009.

Other useful resource(s):

1. Link to NPTEL course contents: https://nptel.ac.in/courses/108101112/
2. Link to topics related to course:
   i. https://nptel.ac.in/courses/108101112/1 to 12

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Parallel and Distributed Algorithms)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	1	**1.7**
CO-2	2	3	3	3	3	1	1	1	2	2	2	1	**2.0**
CO-3	2	2	2	2	3	1	1	1	2	2	2	1	**1.8**
CO-4	2	3	3	3	2	1	1	1	2	3	2	1	**2.0**
Average	**2**	**2.5**	**2.5**	**2.5**	**2.5**	**1.0**	**1.0**	**1.0**	**2.0**	**2.25**	**2.0**	**1.0**	

Medical Image Processing

COURSE CODE: 18B1WEC847

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

1. To introduce various medical imaging modalities.
2. To teach the requirement and development of different blocks of computer aided diagnosis for medical images.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Able to understand different types of medical imaging modalities and would be able to differentiate them with respect to their advantages and limitations.	Familiarity
CO-2	Acquire an ability to analyze and process medical images.	Usage
CO-3	Understand different feature extraction techniques and classifiers used for image classification.	Usage
CO-4	Understand the role of computer aided diagnosis for medical images.	Assessment

Course Contents:

Unit	Contents	Lectures required
1	Introduction to Image Processing:- Acquisition of Images, Image Sampling and quantization; Spatial and histogram based enhancement; Noise modeling, Image restoration. Image transformation.	8
2	Edge Detection and Image Segmentation: Gradient based edge detectors. Intensity thresholding based image segmentation; Region growing and region splitting algorithm; watershed segmentation.	8
3	Medical Imaging Modalities: Working principle, applications and limitations of Computed tomography , X-ray, Magnetic resonance imaging, Ultrasound imaging, and Positron emission tomography; Various Artifacts.	6
4	Image Texture: Types of texture parameters: Statistical analysis of texture (First order statistics and Second order statistics), Grey level co-occurrence matrix, grey-level run length matrix.	8
5	Pattern classification: Supervised and Unsupervised pattern classification, Neural Network classifier, Support Vector Machines.	6
6	Case Studies: Pre-processing, Segmentation, Feature extraction, and Classification of medical images.	6
Total lectures		42

Suggested Text Book(s):

1. Chris Solomon, Toby Breckon: Fundamental of Digital Image Processing, 1st Ed., John Wiley & Sons, 2011.
2. Rangaraj M. Rangayyan: Biomedical Image Analysis, 1st Ed., CRC Press, New York , 2004.

Suggested Reference Book(s):

1. RC Gonzalez, RE Woods, Digital Image Processing, 3rd Ed., Pearson Publisher, 2008.
2. Kayvan Najarian, Robert Splinter: Biomedical Signal and Image Processing, 2nd Ed., CRC Press, 2012

3. Tamal Bose: Digital Signal and Image Processing, 1st Ed., John Wiley & Sons, 2003.

Other useful resource(s):

http://www.nptelvideos.in/2012/12/digital-image-processing.html (Prof P.K. Biswas, IIT Kharagpur)

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes(2) -10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Medical Image Processing)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	3	3	3	3	2	3	1	2	1	2	2.42
CO-2	3	3	3	3	2	0	0	1	2	3	1	1	1.83
CO-3	3	3	3	3	3	1	1	1	1	2	1	1	1.92
CO-4	3	3	3	3	3	3	2	3	2	2	3	3	2.75
Average	3.00	3.00	3.00	3.00	2.75	1.75	1.25	2.00	1.50	2.25	1.50	1.75	

Machine Learning

COURSE CODE: 18B1WCI634

COURSE CREDITS: 2

CORE/ELECTIVE: ELECTIVE

L-T-P: 2-0-0

Pre-requisite: None

Course Objectives:

1. Have a good understanding of the fundamental issues and challenges of machine learning: data, model selection, model complexity, etc.
2. Have an understanding of the strengths and weaknesses of many popular machine learning approaches.
3. Appreciate the underlying mathematical relationships within and across Machine Learning algorithms and the paradigms of supervised and un-supervised learning.
4. Be able to design and implement various machine learning algorithms in a range of real-world applications.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	To learn the basic concepts and terminology in machine learning	Familiarity
CO-2	To learn about the definition of learning systems, their goals and applications in machine learning	Familiarity
CO-3	To understand concepts associated with classification and experimental evaluation of classification algorithms	Assessment
CO-4	To learn concepts associated with decision trees and experimental evaluation of classification algorithms	Assessment
CO-5	To learn about instance-based learning, clustering and unsupervised learning	Usage

Course Contents:

Unit	Contents	Lectures required
1	**Introduction:** Definition of learning systems. Goals and applications of machine learning. Aspects of developing a learning system: training data, concept representation, function approximation. **Inductive Classification:** The concept learning task. Concept learning as search through a hypothesis space. General-to-specific ordering of hypotheses. Finding maximally specific hypotheses. Version spaces and the candidate elimination algorithm. Learning conjunctive concepts. The importance of inductive bias.	5
2	**Decision Tree Learning:** Representing concepts as decision trees. Recursive induction of decision trees. **Picking the best splitting attribute:** entropy and information gain.Overfitting, noisy data, and pruning, Linear regression	5
3	**Artificial Neural Networks:** Neurons and biological motivation. Perceptrons, Multilayer networks and back propagation. **Bayesian Learning:** Probability theory and Bayes rule. Naive Bayes learning algorithm. Logistic regression	5
4	**Support Vector Machine**, Kernel function and Kernel SVM **Instance-Based Learning:** Constructing explicit generalizations versus comparing to past specific examples. k-Nearest Neighbor algorithm. Case-based learning.	5

5	**Genetic Algorithm and Evolutionary Algorithms Introduction.** Representing hypothesis, Genetic Operators, Fitness function and selection. Hypothesis space search Genetic Programming	6
6	**Clustering and Unsupervised Learning:** Learning from unclassified data. Hierarchical Agglomerative Clustering. k-means partitioned clustering. Expectation maximization (EM) for soft clustering. Semi-supervised learning with EM using labeled and unlabeled data.	6
Total lectures		**32**

Suggested Text Book(s):

1. Tom Mitchell, "Machine Learning", McGraw Hill, 1997, ISBN 0070428077
2. Introduction to Machine Learning Edition 2, by Ethem Alpaydin.

Suggested Reference Book(s):

1. Richard o. Duda, Peter E. Hart, and David G. Stork, "Pattern Classification", John Wiley Asia, 2006
2. T. Hastie, R. Tibshirani, & J. H. Friedman, "The Elements of Statistical Learning: Data Mining, Inference, and Prediction", Springer Verlag, 2001.
3. Ian H. Witten & Eibe Frank, "Data Mining: Practical Machine Learning Tools and Techniques with Java Implementations", Morgan Kaufmann, 1999.
4. S. M. Weiss & C. A. Kulikowski, "Computer Systems that Learn", Morgan Kaufman Publishers, San Fancisco, CA, 1991

Other useful resource(s):

1. Link to NPTEL course contents: https://onlinecourses.nptel.ac.in/noc18_cs40/preview
2. Link to topics related to course:
   i. https://in.udacity.com/course/intro-to-machine-learning--ud120-india
   ii. https://www.edx.org/learn/machine-learning
   iii. https://www.datacamp.com/courses/introduction-to-machine-learning-with-r
   iv. https://www.simplilearn.com/big-data-and-analytics/machine-learning-certification-training-course

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment		Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Machine Learning)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	3	2	2	3	2	2	2	3	1	3	**2.4**
CO-2	3	3	3	2	3	2	3	2	2	3	1	3	**2.5**
CO-3	3	3	3	2	3	3	2	2	3	3	1	3	**2.6**
CO-4	3	3	3	2	3	3	2	2	2	3	1	3	**2.5**
CO-5	3	3	3	2	3	3	2	2	2	3	1	3	**2.5**
Average	**3**	**3**	**3**	**2**	**2.8**	**2.8**	**2.2**	**2**	**2.2**	**3**	**1**	**3**	

Approved in Academic Council held on 25.10.2018

Machine Learning Lab

COURSE CODE: 18B1WCI674

COURSE CREDITS: 1

CORE/ELECTIVE: ELECTIVE

L-T-P: 0-0-2

Pre-requisite: None

Course Objectives:

1. To understand the working of Machine learning tools and languages.
2. To learn the implementation of classification techniques for any dataset.
3. To conduct experiments for clustering techniques for any dataset.
4. To discuss different classification and clustering algorithms based on the analysis of results obtained from experimental evaluation.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	To implement classification algorithms in python	Usage
CO-2	To implement Clustering algorithms in python	Usage
CO-3	To implement Genetic Algorithms in Python	Usage
CO-4	Top compare different algorithms based on some common factors	Assessment

List of Experiments:

S. No.	Description	Hours
1	Selection of dataset and brief introduction about Python framework for machine learning experiments.	**2**
2	Dataset upload and visualization in Python. • How to upload a dataset in Python • How to retrieve rows and data in the dataset • How to create visualization of data	**2**
3	Decision tree using Entropy and Information Gain	**2**
4	Random forest tree and evaluation of Decision Tree	**2**
5	Linear Regression	**2**
6	Artificial Neural Network • Perceptron • Multi-Layer Neural Network • Back propagation	**4**
7		
8	Naive Bayes Classifier	**2**
9	Logistic regression	**2**
10	Support Vector Machine, Kernel function and Kernel SVM	**2**
11		
12	Genetic Programming	**2**
13		
14	Clustering: k-means	**2**
Total Lab hours		**26**

Approved in Academic Council held on 25.10.2018

Suggested Books/Resources:

1. Tom Mitchell, “Machine Learning”, McGraw Hill, 1997, ISBN 0070428077
2. Sebastian Raschka, “Python Machine Learning”, Packt Publishing Ltd.
3. Andreas C. Müller, Sarah Guido, “Introduction to Machine Learning with Python”, O'Reilly Media, Inc.
4. Sunila Gollapudi, “Practical Machine Learning”, Packt Publishing Ltd
5. Wes McKinney, “Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython”, O'Reilly Media, Inc.
6. Willi Richert, “Building Machine Learning Systems with Python”, Packt Publishing Ltd.
7. Link to topics related to course:
   i. https://www.python-course.eu/machine_learning.php
   ii. https://www.analyticsvidhya.com/blog/2018/05/24-ultimate-data-science-projects-to-boost-your-knowledge-and-skills/
   iii. https://www.datacamp.com/

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Attendance	15 Marks
4	Lab Assessment	45 Marks
	Total	100 marks

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Average
CO-1	3	2	2	2	3	1	1	1	1	1	2	2	**1.8**
CO-2	3	3	3	3	3	2	1	2	2	1	2	3	**2.3**
CO-3	3	3	2	3	3	2	1	2	2	1	2	3	**2.3**
CO-4	3	3	3	3	3	2	1	2	2	1	2	3	**2.3**
Average	**3**	**2.8**	**2.5**	**2.8**	**3**	**1.8**	**1**	**1.8**	**1.8**	**1**	**2**	**2.8**	

Network Analysis and Synthesis

COURSE CODE: 18B1WEC534

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

1. Circuit analysis in the S domain using Laplace transforms. Analysis of two port networks.
2. Design and analysis of filters and attenuators. Elements of realizability and synthesis of one port networks.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Understand the need and foundation of network analysis	Familiarity
CO-2	Analyze two port networks, filters and attenuators	Assessment
CO-3	Analysis of problem solving, knowledge and reasoning	Assessment
CO-4	Study of application domains for network analysis and synthesis.	Usage

Course Contents:

Unit	Contents	Lectures required
1	Laplace transform and its application in circuit analysis : Laplace Transformation, laplace transforms of some important functions, properties of laplace transforms, step function, impulse function, laplace transform of periodic functions, inverse transforms, initial and final value theorms. Circuit elements in the S domain, Transfer function, use of transfer function in circuit analysis, the transfer function and the convolution integral, the transfer function and the steady state sinusoidal response, the impulse function in circuit analysis.	8
2	S- Domain Analysis: Concept of complex frequency, physical interpretation of complex frequency, transform impedance and transform circuits, series and parallel combinations of elements, terminal pair or ports, network function for one port and two port networks, poles and zeros of network functions, significance of poles and zeros, properties of driving point functions, properties of transfer functions, necessary condition for a driving point function, necessary condition for transfer functions, time domain response from pole zero plot, amplitude and phase response from pole zero plot, stability criteria for an active network, routh criteria.	9
3	Two- Port networks: Two port networks, open circuit (Z) parameters, short circuit (Y) parameters, transmission (ABCD) parameters, inverse transmission (A' B'C'D')parameters, Hybrid (H) parameters, Inverse Hybrid(G) parameters, inter relationships of different parameters, interconnection of two port networks, T and ∏ representations, terminated two port network, lattice network, Image networks.	8
4	Filters and Attenuators: Classification of filters, filter networks, equation of filter networks, classification of pass band and stop band, characteristic impedance in the pass band and stop bands, constant –K low pass filter, constant –K high pass filter, m derived T- section, band pass filter, band elimination filter, attenuators, T- type attenuator, ∏- type attenuator, lattice attenuator, bridged –T attenuator, L- type attenuator, equalizers, inverse network, series equalizer, full series equalizer, shunt equalizer, full shunt equalizer, constant – resistance equalizer, bridged –T attenuation equalizer, bridged –T phase equalizer, lattice attenuation equalizer, lattice phase equalizer.	9
5	Elements of realizability and synthesis of one port networks : Hurwitz polynomials, positive real functions, frequency response of reactive one ports, synthesis of reactive one ports by foster's method, synthesis of reactive one ports by Cauer's method, synthesis of R-L network by foster's method, synthesis of R-L network by Cauer's method, synthesis of R-C network by foster's method, synthesis of R-C network by Cauer's method.	8
Total lectures		42

Suggested Text Book(s):

1. A sudhakar, shyammohan S palli" Circuits and networks Analysis and synthesis", Fifth Edition, Tata Mcgraw Hill.
2. M E Van Vakenburg,"Network Analysis and synthesis", Third edition, Pearson

Suggested Reference Book(s):

1. Ravish R Singh, "Network Analysis and synthesis", Tata Mcgraw Hill.

Other useful resource(s):

Link to topics related to course: https://nptel.ac.in/courses/106105154

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Network Analysis and Synthesis)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	2	3	3	3	1	1	1	2	2	2	2	2.08
CO-2	2	3	2	3	2	1	1	1	2	2	1	2	1.83
CO-3	2	3	3	2	2	1	1	1	2	2	1	2	1.83
CO-4	2	3	3	3	2	1	1	1	2	3	1	2	2.00
Average	2.25	2.75	2.75	2.75	2.25	1	1	1	2	2.25	1.25	2	

Nano-Biotechnology

COURSE CODE: 18B1WBT633

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Basic of Physics, Chemistry and Biology

Course Objectives:

1. Introduction to Nanomaterial and various material used for obtaining nano-materials
2. Learn various approaches or methods used for nanomaterial synthesis.
3. To learn various analytical techniques used for nanomaterial characterization.
4. Learn various applications of nanomaterial in health care, agriculture and environmental monitoring

Course Outcomes

S. No.	Course Outcomes	Level of Attainment
CO-1	Introduction to Nano (Basics to Nanoscience and Nanotechnology)	Familiarity
CO-2	Introduction to the two approaches (bottom up and top down) followed for the synthesis of nanomaterial and fundamental properties of Nano-materials(Nano-effect)	Assessment & Technical
CO-3	Introduction to various technique used for the characterization of nanostructures and nanomaterial.	Assessment & Technical
CO-4	Fundamental understanding of nanomaterial/nano-biotechnological application in health and disease.	Usage
CO-5	Fundamental understanding of nanomaterial/nano-biotechnological application in Environment and food - detection and mitigation	Usage

Course Contents:

Unit	Contents	Lectures required
1	**Introduction, History &Applications:**Various definitions and Concept of Nano-biotechnology & Historical background. Fundamental sciences and broad areas of Nano-biotechnology. Various applications of Nano- biotechnology, Cell – Nanostructure interactions	**6**
2	**Synthetic methodologies:**Introduction to the two approaches (bottom up and top down) followed for the synthesis of nanomaterials: Lithography method, Electrochemical method, Mechanical Method, Chemical Synthesis, Chemical vapour deposition, Molecular self-assembly, Laser Induced assembly.	**10**
3	**Techniques used for the characterization of nanoparticles:**Principles of microscopy-light, electron, fluorescent confocal, scanning and transmission microscopes, different fixation and staining techniques for EM. Principles of spectroscopy-UV, visible, CD, FTIR, NMR, and ESR spectroscopy, structure determination using X-ray diffraction, analysis using light scattering.	**13**
4	**Nano-biotechnologicalapplications in health and disease:**Properties of different types of nanoparticles normally used in health and disease. Diagnostics and theranostics application of nanomaterials in health sciences.	**6**
5	**Nanobiotechnological applications in Environment andfood - detection and mitigation:**Properties of different types of nanoparticles normally used in environmental and food sciences. Detection and removal of toxic metal ion from polluted sample and detection and removal of pathogen form food sample.	**7**
Total Lectures		**42**

Approved in Academic Council held on 25.10.2018

Suggested Text Book(s):

1. C. A. Mirkin and C. M. Niemeyer. Nanobiotechnology - II more concepts and applications. (2007) - Wiley VCH.
2. P. Boisseau, P. Houdy, M. Lahmani, Nanoscience: Nanobiotechnology and Nanobiology

Suggested Reference Book(s):

1. A. Nouailhat, An Introduction to Nanoscience and Nanotechnology, Wiley
2. D.A Phoenix, W. Ahmed, Nanobiotechnology, One Central Press Ltd, UK
3. L. Filipponi, D. Sutherland, Nanotechnologies: Principles, Applications, Implications and Hands-on Activities.Directorate- European commission

Other useful resource(s): Link to NPTEL course contents

- https://nptel.ac.in/courses/118107015/
- https://onlinecourses.nptel.ac.in/noc17_bt17/preview
- http://videos.gitam.edu/nptel/nano.html

Evaluation Scheme:

S. No.	Exam	Marks	Duration	Coverage/Scope of Examination
1	T-1	15	1 Hour	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Quiz, Assignment, Attendance, etc.

Course Outcomes (COs) contribution to the programme Outcomes (POs):

Course outcomes (NanoBiotech.)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	1	1	2	3	2	1	1	1	2	2	1.7
CO-2	2	3	2	2	3	2	2	2	1	1	3	2	2.1
CO-3	3	3	2	2	3	2	2	2	1	1	3	2	2.2
CO-4	2	2	3	3	2	3	2	2	2	2	3	2	2.3
CO-5	2	2	3	3	2	3	3	2	2	1	3	2	2.3
Average	2.2	2.4	2.2	2.2	2.4	2.6	2.2	1.8	1.4	1.2	2.8	2.0	

Networked Embedded Control Systems

COURSE CODE: 18B1WEC831

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Knowledge of Networked and Control Systems.

Course Objectives:

The main objective of the course is to

1. Present an overview of the Networked Embedded Control Systems (NECS) as an emerging field of control system.
2. Modeling, performance analysis and design approach of Networked Embedded Control Systems.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Introduction, analysis and design of NECS.	Familiarity
CO-2	Overview of emerging fields of NECS.	Familiarity
CO-3	Modeling and analysis of communication system and Control Systems aspects of NECS.	Assessment
CO-4	Performance analysis of networked embedded control system.	Assessment
CO-5	Familiarity with the applications of NECS.	Usage

Course Contents:

Unit	Contents	Lectures required
1	Introduction to the control systems relying on communication networks. Overview of emerging fields (cyber-physical systems and the Internet of Things) of networked embedded control systems.	**8**
2	Provisioning of wireless/wired sensor and actuator network for the network control systems.	**9**

3	Modeling and analysis of communication system aspect of Networked Embedded Control Systems. Modeling and analysis of control system aspect of Networked Embedded Control Systems.	**10**
4	Performance of networked control system in terms of stability, delay and packet loss. Methods for analyzing the performance of networked control system.	**8**
5	Demonstration of Networked Embedded Control Systems via Testbed.	**6**
Total lectures		**42**

Suggested Text Book(s):

1. Wang, Fei-Yue, Liu, Derong, Networked Control Systems Theory and Applications, Springer-Verlag, 2008.
2. P. J. Antsaklis, P. Tabuada, Networked Embedded Sensing and Control, Springer, 2006.

Suggested Reference Book(s):

1. Magdi Mahmoud, Yuanqing Xia, Networked Control Systems, Elsevier, 2019.
2. Alberto Bemporad, Maurice Heemels, Mikael Johansson, Networked Control Systems, Springer, 2010.

Other useful resource(s):

Link to topics related tocourse:

i. http://www.infocobuild.com/education/audio-video-courses/electronics/EmbeddedSystems-IIT-Delhi/lecture-24.html
ii. https://www.cds.caltech.edu/~murray/wiki/index.php/E08:_Introduction_to_Networked_Control_Systems
iii. http://euler.ecs.umass.edu/ece655/
iv. http://magnus.ece.gatech.edu/ece8823.html

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2

3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes(2) -10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Networked Embedded Control Systems)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	2	2	1	1	2	2	2	2	2	1	2	1.8
CO-2	3	3	2	2	1	2	2	2	2	2	1	2	2
CO-3	3	2	3	2	1	3	2	2	2	3	2	3	2.3
CO-4	3	1	3	2	3	2	2	2	2	3	2	3	2.4
CO-5	3	2	3	3	2	2	2	2	2	2	3	3	2.5
Average	3	1.9	2.4	2.3	1.6	1.75	2	2	2	2.3	2	2.6	

Computer Vision

Structure: 3-0-0
Instructor: Mr. Nitin Kumar
OE for B Tech 8th Sem CSE/IT

Objectives:
Computer Vision focuses on development of algorithms and techniques to analyze and interpret the visible world around us. This requires understanding of the fundamental concepts related to multi-dimensional signal processing, feature extraction, pattern analysis visual geometric modeling, stochastic optimization etc. Knowledge of these concepts is necessary in this field, to explore and contribute to research and further developments in the field of computer vision. Applications range from Biometrics, Medical diagnosis, document processing, mining of visual content, to surveillance, advanced rendering etc.

Course Outcomes(COs):

Srl	Course Outcomes (Computer Vision)	Level of Attainment
CO-1	To understand the concepts of digital image processing	Familiarity
CO-2	To understand the concepts of depth estimation and Multi-camera views	Assessment
CO-3	To understand the concepts of Feature Extraction	Assessment
CO-4	To understand the concepts of Image Segmentation	Assessment
CO-5	To understand the concepts of Pattern Analysis	Usage
CO-6	To understand the concepts of Motion Analysis	Assessment
CO-7	To understand the concepts of Shape formation	Usage

Course Outline:
UNIT - I- Digital Image Formation and low-level processing
Overview and State-of-the-art, Fundamentals of Image Formation, Transformation: Orthogonal, Euclidean, Affine, Projective, etc; Fourier Transform, Convolution and Filtering, Image Enhancement, Restoration, Histogram Processing

UNIT-II- Depth estimation and Multi-camera views
Perspective, Binocular Stereopsis: Camera and Epipolar Geometry; Homography, Rectification, DLT, RANSAC, 3-D reconstruction framework; Auto-calibration

UNIT-III- Feature Extraction
Edges - Canny, LOG, DOG; Line detectors (Hough Transform), Corners - Harris and Hessian Affine, Orientation Histogram, SIFT, SURF, HOG, GLOH, Scale-Space Analysis- Image Pyramids and Gaussian derivative filters, Gabor Filters and DWT.

UNIT-IV- Image Segmentation
Region Growing, Edge Based approaches to segmentation, Graph-Cut, Mean-Shift, MRFs, Texture Segmentation; Object detection

UNIT-V- Pattern Analysis
Clustering: K-Means, K-Medoids, Mixture of Gaussians, Classification: Discriminant Function, Supervised, Un-supervised, Semi-supervised; Classifiers: Bayes, KNN, ANN models; Dimensionality Reduction: PCA, LDA, ICA; Non-parametric methods

UNIT-VI- Motion Analysis
Background Subtraction and Modeling, Optical Flow, KLT, Spatio-Temporal Analysis, Dynamic Stereo; Motion parameter estimation

UNIT-VII- Shape from X
Light at Surfaces; Phong Model; Reflectance Map; Albedo estimation; Photometric Stereo; Use of Surface Smoothness Constraint; Shape from Texture, color, motion and edges

Lecture Plan:

Srl	**Computer Vision**	Lectures
1.	UNIT - I- Digital Image Formation and low-level processing Overview and State-of-the-art, Fundamentals of Image Formation, Transformation: Orthogonal, Euclidean, Affine, Projective, etc; Fourier Transform, Convolution and Filtering, Image Enhancement, Restoration, Histogram Processing	5
2	UNIT-II- Depth estimation and Multi-camera views Perspective, Binocular Stereopsis: Camera and Epipolar Geometry; Homography, Rectification, DLT, RANSAC, 3-D reconstruction framework; Auto-calibration	7
3	UNIT-III- Feature Extraction Edges - Canny, LOG, DOG; Line detectors (Hough Transform), Corners - Harris and Hessian Affine, Orientation Histogram, SIFT, SURF, HOG, GLOH, Scale-Space Analysis- Image Pyramids and Gaussian derivative filters, Gabor Filters and DWT.	6
4	UNIT-IV- Image Segmentation Region Growing, Edge Based approaches to segmentation, Graph-Cut, Mean-Shift, MRFs, Texture Segmentation; Object detection	7
5	UNIT-V- Pattern Analysis Clustering: K-Means, K-Medoids, Mixture of Gaussians, Classification: Discriminant Function, Supervised, Un-supervised, Semi-supervised; Classifiers: Bayes, KNN, ANN models; Dimensionality Reduction: PCA, LDA, ICA; Non-parametric methods	5
6	UNIT-VI- Motion Analysis Background Subtraction and Modeling, Optical Flow, KLT, Spatio-Temporal	8

	Analysis, Dynamic Stereo; Motion parameter estimation	
7	UNIT-VII- Shape from X Light at Surfaces; Phong Model; Reflectance Map; Albedo estimation; Photometric Stereo; Use of Surface Smoothness Constraint; Shape from Texture, color, motion and edges	4

Evaluation Scheme:

Test 1	15
Test 2	25
Test 3	35
Internal Assessment	25
Total	100

Textbooks:

- Richard Szeliski, Computer Vision: Algorithms and Applications, Springer-Verlag London Limited 2011
- Computer Vision: A Modern Approach, D. A. Forsyth, J. Ponce, Pearson Education, 2003

References

- Richard Hartley and Andrew Zisserman, Multiple View Geometry in Computer Vision, Second Edition, Cambridge University Press, March 2004
- K. Fukunaga; Introduction to Statistical Pattern Recognition, Second Edition, Academic Press, Morgan Kaufmann, 1990
- R.C. Gonzalez and R.E. Woods, Digital Image Processing, Addison- Wesley, 1992

CO-PO Articulation (Computer Vision)

Srl	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Weightage
CO-1	3	3	3	2	3	3	2	2	2	2	2	3	60%
CO-2	3	3	3	2	2	2	2	2	2	2	2	3	77%
CO-3	3	3	3	2	3	2	2	2	2	2	2	3	85%
CO-4	3	3	3	2	3	2	2	2	2	2	2	3	85%
CO-5	3	3	3	2	3	2	2	2	2	2	2	3	85%
CO-6	3	3	3	2	3	2	2	2	2	2	2	3	85%
CO-6	3	3	3	3	3	3	3	3	3	3	3	3	70%
Weightage	100%	100%	100%	70%	80%	90%	60%	80%	100%	70%	80%	100%	

Graduate Attributes/Program Outcomes		
PO-1	Engineering knowledge	
PO-2	Problem analysis:	
PO-3	Design/development of solutions:	
PO-4	Conduct investigations of complex problems:	
PO-5	Modern tool usage:	
PO-6	The engineer and society:	
PO-7	Environment and sustainability:	
PO-8	Ethics:	
PO-9	Individual and team work:	
PO-10	Communication:	
PO-11	Project management and finance:	
PO-12	Life-long learning:	

CO- PSOs Articulation					
Sr No	PSO-1	PSO-2	PSO-3	PSO-4	
CO-1	3	2	2	2	79
CO-2	2	3	2	3	79
CO-3	3	2	3	2	81
CO-4	2	2	2	2	75
CO-5	2	3	2	3	79
CO-6	3	2	3	2	79
Average Score	81	82	85	76	

Program Specific Outcomes	
PSO-1	Detailed Knowledge of contemporary issues in CSE.
PSO-2	Strong skills in learning new programming environments.
PSO-3	Ability to analyse, design, model, develop, test and manage complex software and information management systems.
PSO-4	Analysing the impact of Computer Science and Engineering solutions in the societal and human context.

Open Channel Flow and Hydraulic Machines

COURSE CODE:18B1WCE639

COURSE CREDITS: 3

CORE/ELECTIVE: Elective

L-T-P: 3-0-0

Pre-requisite: Fluid mechanics

Course Objectives:

1. To familiarize students with the knowledge of open channel and their behaviors
2. To study the various applications, open channels
3. To study different types of turbines and their application
4. To get familiar with working of different types of pumps and its applications

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Knowledge of flow characteristics of open channel flow.	Assessment
CO-2	Learn the different flow regimes in open channels and their characteristics Predict if hydraulic jumps are to occur during flow, and calculate the fraction of energy dissipated during hydraulic jumps	Assessment
CO-3	Methods of discharge measurement, various phenomenon of flow in open channel	Assessment
CO-4	Different types of turbines, and its applications, working principles, efficiencies and problems associated with turbines	Assessment
CO-5	Knowledge of pumps, its applications, working principles, efficiencies and problems associated with pumps	Assessment

Course Contents:

Unit	Contents	Lectures required
1	**Introduction to Open Channel Flow:** Comparison between open channel flow andpipe flow, geometrical parameters of a channel, classification of open channels, classificationof open channel flow, Velocity Distribution of channel section.	4

2	**Uniform Flow:** Continuity Equation, Energy Equation and Momentum Equation, Characteristics of uniform flow, Chezy's formula, Manning's formula. Factors affecting Manning's Roughness Coefficient, Most economical section of channel. Computation of Uniform flow, Normal depth	**7**
3	**Non-Uniform Flow:** Specific energy, Specific energy curve, critical flow, discharge curve Specific force Specific depth, and Critical depth. Channel Transitions, Measurement of Discharge and Velocity – Venturi Flume, Standing Wave Flume, Parshall Flume, Broad Crested Weir. Measurement of Velocity- Current meter, Floats, Hot-wire anemometer	**9**
4	**Hydraulic Jump:** Theory of hydraulic jump, Elements and characteristics of hydraulic jump in a rectangular Channel, length and height of jump, location of jump, Types, applications and location of hydraulic jump.	**5**
5	**Hydraulic Turbines:** Efficiencies &Classification, Pelton wheel turbine: Design , Velocity triangle , Radial flow Reaction turbines: working principles and Design of, Francis and Kaplan Turbine, Velocity Triangles, Draft tube : Types and theory, specific speed, Operating characteristics . Turbines, Selection of Turbines.	**9**
6	**Pumps:** Classification, Centrifugal pump Components and working, Velocity triangles, Head Losses and Efficiencies, Minimum starting speed, priming of centrifugal pump, specific speed, Cavitation, selection of pumps, Reciprocating pump, types, Components and working, slip, Indicator diagram, Air vessel.	**8**
Total lectures		**42**

Suggested Text Book(s):

1. Modi, P.N. and Seth, S.M., Hydraulic and Fluid Machines, Standard book house New Delhi, 1995.
2. K. Subramanya, Flow in Open Channels, Tata Mc. Graw Hill, 2009
3. K.G. Rangaraju, Flow through Open Channels, Tata Mc. Graw Hill, 2013

Suggested Reference Book(s):

1. M.H Chaudhury: Open Channel Flow, Prentice Hall of India, 2008
2. V.T Chow: Open Channel Hydraulics, Mc Graw Hill, 2009.
3. Terry W. Sturm, Open Channel Hydraulics, Tata Mc. Graw Hill, 2009.
4. Richard H. French, Open Channel Hydraulics, Mc Graw Hill, 1985

Other useful resource(s):

1. Link to NPTEL course contents:https://nptel.ac.in/courses/105103096/ https://nptel.ac.in/courses/112104117/33

Department of Civil Engineering

Approved in Academic Council held on 28 July 2021

https://nptel.ac.in/courses/105103021/1

2. Link to topics related tocourse:
   https://nptel.ac.in/courses/105103096/1-24
   https://nptel.ac.in/courses/105103021/40-43

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (5) - 10 Quizzes(2) -10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course Outcomes (Open Channel Flow and Hydraulic Machine)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	2	2	2	2	3	x	x	1	1	1	3	**2**
CO-2	3	3	2	2	2	3	x	x	2	1	1	3	**2.2**
CO-3	3	3	3	2	2	2	x	x	2	2	1	3	**2.3**
CO-4	3	3	3	3	3	2	x	x	2	2	3	3	**2.7**
CO-5	3	3	3	3	3	2	x	x	2	2	3	3	**2.7**
Average	**3**	**2.8**	**2.6**	**2.4**	**2.4**	**2.4**	**0**	**0**	**1.8**	**1.6**	**1.8**	**3**	

Optical Networks

COURSE CODE: 18B1WEC842

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Mathematical Physics

Course Objectives:

1. To expose the students to the basics of signal propagation through optical fibers, fiber impairments, components and devices and system design.
2. To make the students aware of the hardware used for practical purposes.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Recognize and classify the structures of Optical fiber and types.	Familiarity
CO-2	Discuss single hop and multihop fibers.	Assessment
CO-3	Analyze various coupling losses.	Assessment
CO-4	Get acquainted with optical switching.	Usage
CO-5	Get familiar with the recent optical networks used for practical purposes.	Usage

Course Contents:

Unit	Contents	Lectures required
1	Optical Networking-Introduction and Challenges: Advantages of optical network, telecom network overview and architecture, WDM optical networks, WDM network evolution, WDM network construction, broadcast and select optical WDM network, wavelength routed optical WDM network.	7
2	Optical Networking Components/Building Blocks : Optical transmitters, semiconductor laser diode, tunable and fixed laser, laser characteristics, photodectors, tunable and fixed optical filters, channel equalizers, optical amplifiers and its characteristics, semiconductor laser amplifier, Raman amplifier, doped fiber amplifier, various switching elements.	8
3	Single and Multi-hop Networks: Introduction to single and multi-hop networks, Characteristics of single and multi-hop networks, experimental single hop networks: LAMBDANET, STARNET, SONATA, Rainbow, experimental multi-hop networks: Shufflenet, De Bruijn Graph, Hypercube.	8
4	Optical switching: Optical packet switching basics, slotted and unslotted networks, header and packet format, contention resolution in OPS networks, self routing, examples on OPS node architecture.	8
5	Optical Access and Metro Network: Introduction to access network, PON, EPON and WDN EPON: overview, principal of operation, architecture; dynamic wavelength allocation, STARGATE: overview, need, architecture, operation and application, gigabit Ethernet, radio over fiber network. Introduction to metro network, overview of traffic grooming in SONET ring, traffic grooming in WDM ring, Interconnected WDM networks, packet communication using tunable WADM.	11
Total lectures		42

Suggested Text Book(s):

1. Optical Network Series:Biswanath Mukherjee, Springer, 2006.
2. Optical Networks: R.Ramaswami and K.Sivarajan, Â Morgan Kaufmann Publishers, 2nd Edition, 2002.
3. Optical Switching Networks: Mayer & Martin, Cambridge University Press, 2008.
4. Optical Fiber Communications- Principles and Practice by John M Senior, 3rd Edition, Pearson Education India.

Suggested Reference Book(s):

1. Data Communication by Behrouz Â, A Forouzan, Mc Graw Hill, 4th Edition.
2. Optical Switching: Tarek S. El. Bawab, Springer.

Other useful resource(s):

1. http://www.iec.org/online/tutorials/acrobat/opt_net.pdf
2. http://www.pdf-search-engine.com/optical-networking-pdf.html
3. http://www.networktutorials.info/networkhowto/what_is_optical_networking.html
4. http://www.urec.fr/hd/DWDM/ALCATEL/optical_network.pdf

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes(2) -10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Optical Networks)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	1.75
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	2
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	1.75
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	2.08
CO-5	2	3	3	3	2	1	1	1	2	3	2	2	2.08
Average	2	2.6	2.6	2.6	2.4	1	1	1	2	2.4	1.6	2	

OPTIMIZATION TECHNIQUES

COURSE CODE: 18B1WCE640

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Course Objectives:

1. To provide optimal solutions to a particular engineering problem.
2. To impart understanding of mathematical tools for solution of engineering problems.
3. To apply modern computer aided tools for solution of optimization problems.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Understanding the fundamentals of application of Optimization Techniques to Engineering Problems.	Assessment
CO-2	Application of Mathematical modeling to render complex engineering problems solvable.	Assessment
CO-3	Utilization of computer/software tools to solve optimization problems.	Assessment

Course Contents:

Unit	Contents	Lectures required
1.	Optimization technique's introduction	**2**
2.	Linear Programming Problems (LPP): Definition of LPP, Simplex Method, Artificial Variable Method, Two Phase Method, using MS-EXCEL, reverse simplex, dual problems, Sensitivity analysis	**10**
3.	Study of Mathematical Models, Graphical Solutions of Linear Programming Problems (LPP), Random variables, Binomial,	**8**

	Poisson, Exponential and Normal Distribution	
4.	Non- Linear Programming Problems (NLP). Quadratic programming,	**2**
5.	Geometric programming, Goal programming, Resource allocation, Integer programming, dynamic programming, Game theory	**8**
6.	Transportation Problems: Introduction to Transportation Model, Matrix Form of TP, Applications of TP Models, Basic Feasible Solution of a TP, Degeneracy in TP, Formation of Loops in TP, Solution Techniques of TP, Different Methods for Obtaining Initial Basic Feasible Solutions Viz. Matrix Minima Method, Row Minima Method, Column Minima Methods, Using MS_EXCEL	**8**
7.	Evolutionary algorithms for optimization and search, Multi objective optimization – Weighted and constrained methods; Multi level optimization	**4**
TOTAL		**42**

Suggested Text Book(s):

1. Taha, Hamdy A., Operation Research: An Introduction, Prentice Hall.
2. Rao S.S, Engineering Optimization, theory and practice, New age International

Suggested Reference Book(s):

1. E Polak, Computational Methods in Optimization, Academic Press, New York
2. P E Gill, W Murray and M H Wright, Practical Optimization, Academic Press, New York
3. S J Gass, Linear Programming, McGraw Hill Book Co. New York
4. LjungLennant, System identification: theory for the users, Prentice Hall, India
5. Vedula and Mujumdar Water Resources System Analysis TMH.
6. Deb Kalyanmony, Optimization for engineering design, Prentice Hall, India

Other useful resource(s):

1. Link to NPTEL course: https://nptel.ac.in/courses/105/108/105108127/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Throughout the Semester	Assignment (4) – 10 Quizzes(2)-10 (Best Score) Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course Outcomes (Optimization Techniques)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	2	3	2	2	3	1	2	1	2	3	**2.25**
CO-2	3	3	3	3	3	3	3	2	3	1	2	3	**2.67**
CO-3	3	3	3	2	3	2	3	2	3	1	3	3	**2.58**
Average	**3**	**3**	**2.67**	**2.67**	**2.67**	**2.33**	**3**	**1.67**	**2.67**	**1**	**2.33**	**3**	

Optimization Techniques in Engineering

COURSE CODE: 18B1WEC739

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

1. To understand the need and origin of the optimization methods.
2. To get a broad picture of the various applications of optimization methods used in engineering.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Cast engineering minima/maxima problems into optimization framework.	Familiarity
CO-2	Learn efficient computational procedures to solve optimization problems.	Familiarity
CO-3	To design algorithms, the repetitive use of which will lead reliably to finding an approximate solution.	Assessment
CO-4	Analyze and appreciate variety of performance measures for various optimization problems.	Assessment
CO-5	Understand importance of optimization of industrial process management.	Usage

Course Contents:

Unit	Contents	Lectures required
1	Introduction: Functions and Continuity, Optimization and Optimality, Optimization Problem Formulation, Engineering Optimization Problems, Classification of Optimization Algorithms, Order and Notations, Convergence Rate, Computational Complexity, Convexity, Stochastic Nature in Algorithms	6
2	Optimization Techniques and Algorithms: Unconstrained Optimization, Gradient-Based Methods, Newton's Method, Convergence Analysis, Steepest Descent Method, Line Search, Conjugate Gradient Method, Stochastic Gradient Descent, Subgradient Method, Gradient-Free Nelder–Mead Method	7
3	Constrained Optimization: Mathematical Formulation, Lagrange Multipliers, Slack Variables, Generalized Reduced Gradient Method, KKT Conditions, Penalty Method.	7
4	Approximation Optimization Methods: BFGS Method, Trust-Region Method, Sequential Quadratic Programming, Convex Optimization, Equality Constrained Optimization, Barrier Functions, Interior-Point Methods, Stochastic and Robust Optimization.	7
5	Modern Methods of Optimization: Genetic Algorithms, Simulated Annealing, Particle Swarm Optimization.	7
6	Multi-Objective Optimization: Pareto Front and Pareto Optimality, Choice and Challenges, Weighted Sum Method, Utility Function Method, Multi-objective Genetic Algorithms, Multi-objective Particle Swarm Optimization	8
Total lectures		42

Suggested Text Book(s):

1. Parkinson, A.R., Balling, R., and J.D. Hedengren: Optimization Methods for Engineering Design, 2nd Edition, Brigham Young University, 2018.
2. Deb K: Optimization for Engineering Design: Algorithms and Examples, 2nd Edition, Prentice Hall India Learning Private Limited, 2012.
3. Xin-She Yang: Optimization Techniques and Applications with Examples, 1st Edition, Wiley, 2018.

Suggested Reference Book(s):

1. A. D. Belegundu and T. R. Chandrupatla: Optimization Concepts and Applications in Engineering, 2nd Edition, Cambridge University Press, 2011.
2. Xin-She Yang: Engineering Optimization: An Introduction with Metaheuristic Applications, 1st Edition, Wiley, 2010.

Other useful resource(s):

Link to NPTEL course contents:Optimization Methods: https://nptel.ac.in/courses/105108127/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (3) - 10 Quizzes(3) -10 Attendance - 5

Course Outcomes (COs) contribution to the ProgrammeOutcomes (POs)

Course outcomes (Optimization Techniques in Engineering)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	2	2	1	2	1	2	1	1	1	2	2	1.67
CO-2	3	2	2	1	2	1	3	1	1	1	2	2	1.75
CO-3	3	3	2	2	3	2	3	1	1	1	3	3	2.25
CO-4	3	3	2	2	3	2	3	1	1	1	3	3	2.25
CO-5	3	3	3	3	3	2	3	1	2	1	3	3	2.50
Average	3	2.6	2.2	1.8	2.6	1.6	2.8	1	1.2	1	2.6	2.6	

Electrical Machines

COURSE CODE: 18B1WEC740

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

To prepare students to perform the analysis of any electromechanical system and empower them to understand the working of electrical equipment used in daily life.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	The ability to formulate and then analyze the working of any electrical machine using mathematical model under loaded and unloaded conditions.	Familiarity
CO-2	The skill to analyze the response of any electrical machine.	Usage
CO-3	The ability to troubleshoot the operation of an electrical machine.	Usage
CO-4	The ability to select a suitable measuring instrument for a given application.	Assessment
CO-5	The ability to estimate and correct deviations in measurements due to the influence of the instrument and due to the accuracy of the instrument	Assessment

Course Contents:

Unit	Contents	Lectures required
1	Basics of electrical machines: Electromagnetism; magnetic field; torque; electromechanical energy conversion principle, Review of magnetic circuits: Magnetic materials, BH characteristics, Magnetomotive Force (MMF); Magnetic Field Strength; Permeability, Reluctance, Permeance; Analogy between Electric and Magnetic Circuits.	2
2	Transformers: Principle of Operation, EMF Equation; Ideal Transformer, Conditions for Ideal Transformer, Transformation Ratio, Volt-Amperes, Impedance Transformation. Practical Transformer at No Load, Effect of Magnetization, Effect of Core Losses: (i) Hysteresis Loss, (ii) Eddy-Current Loss; Construction of Transformer, Core of Transformer: (ii) Core Type Transformer; (ii) Shell Type Transformer. Ideal Transformer on Load; Practical Transformer on Load : Effect of Winding Resistance, Effect of Flux Leakage; Equivalent Circuit of a Transformer, Phasor Diagram, Simplified Equivalent Circuit, Approximate Equivalent Circuit. Voltage Regulation of a Transformer, Approximate Voltage Drop, Exact Voltage Drop; Condition for Zero Regulation, Condition for Maximum Regulation. Efficiency of a Transformer; All-day Efficiency.	7
3	Synchronous Machines: Electro-Mechanical Energy-Conversion Machines: Power Considerations for a Generator and Motor; How a Generator Differs from a Motor; Type of Rotary Machines. General Characteristics of the Synchronous Machine; Synchronous Speed; Rotating Magnetic Flux due to Three-Phase Currents; EMF Equation. Synchronous Motors; Phasor Diagrams for Generator and Motor; Constant Speed Operation; Operation of a Synchronous Motor; Effect of Change in Mechanical Load, Effect of Change in Excitation, Synchronous Condenser.	7

4	Induction Motor : Principle of Working; Slip of Induction Motor; Construction of Induction Motor; Rotor EMF, Current and Power Factor. Torque-Slip Characteristics; Condition for Maximum Torque; Maximum Torque; Effect of Rotor Resistance on the Starting Torque.	4
5	DC Machines : Construction of a DC Machine; Armature Winding; EMF Equation for a DC Generator . Types of DC Machines; A DC Machine as Generator or Motor; Types of DC Generators; Losses in a DC Machine; Efficiency of a DC Generator; Condition for Maximum Efficiency. Characteristics of DC Generators; Open-Circuit Characteristic (OCC). DC Motors; Equivalent Circuit of a DC Motor; Speed Regulation of a DC Motor; Torque Developed by a DC Motor; Torque and Speed Characteristics of a DC Motor.	8
6	Fractional Horse Power Motors: Introduction; Single-Phase Motors, Double-Field Revolving Theory; Types of Single-Phase Motors. Stepper Motors: Types of Stepper Motors; Variable reactance (VR) stepper motors, Permanent magnet stepper motor, Hybrid motor. one-phase on Mode, two-phase on mode, half step mode, microstepping mode.	5
7	Measurement and Error: Definitions; Accuracy and Precision; Significant Figures; Gross errors; Limiting Errors.	1
8	Electrical Instruments: Essentials of an Instrument: (1) Deflecting Torque; (2) Controlling Torque; (3) Damping Torque. Permanent Magnet Moving Coil (PMMC) Instruments; Ammeters; (*Multi-Range Ammeter*); Universal Shunt for Extending Current Ranges; Voltmeters; (*Multi-Range Voltmeter, AC Voltage Measurement).* The Series-Type Ohmmeter; Meter Sensitivity; Loading Effect; Multimeter; Dynamometer Wattmeter; Single-Phase Induction Type Energy Meter.	4
9	Measurement of Non-electrical Quantities: Sensors and transducers, Strain gauge, LVDT, piezoelectric, inductive and capacitive transducers, Hall Effect transducer, light and temperature sensors, proximity sensors.	4
Total lectures		42

Suggested Text Book(s):

1. D C Kulshreshtha: Basic Electrical Engineering, 1st Edition, McGraw Hill Education, 2011.
2. Helfrick and Cooper: Modern Electronic Instrumentation and Measurement Techniques, 1st Edition, PHI, 1992.

Suggested Reference Book(s):

1. B.L. Theraja, A.K. Theraja: A Textbook of Electrical Technology: Basic Electrical Engineering Vol- I, 23rd Edition, S Chand and Company Ltd, 2015.
2. B.L. Theraja, A.K. Theraja: A Textbook of Electrical Technology Vol II: AC and DC Machines, 23rd Edition, S Chand and Company Ltd, 2015
3. V.N. Mittle, Arvind Mittal: Basic Electrical Engineering, 2nd Edition Tata McGraw Hill Publishing Co, 2015.

Other useful resource(s):

1. Link to NPTEL course contents: https://nptel.ac.in/courses/108106071/
2. Link to topics related to course:
   https://nptel.ac.in/courses/108106071/1-24
   https://nptel.ac.in/courses/108105017/6
   https://nptel.ac.in/courses/108105017/21
   https://nptel.ac.in/courses/108105017/24

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Electrical Machines)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	3	2	1	1	1	1	1	2	2	2	1.73
CO-2	3	2	2	2	2	2	2	2	2	2	2	2	2.00
CO-3	1	1	2	2	3	2	3	3	3	3	3	3	2.60
CO-4	2	3	2	2	2	2	3	3	3	3	3	3	2.58
CO-5	1	2	2	2	2	3	3	2	2	3	3	3	2.56
Average	2.00	2.20	2.20	2.00	2.00	2.00	2.40	2.20	2.20	2.60	2.60	2.60	

Biomedical Signal Processing

COURSE CODE: 18B1WEC741

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

1. To introduce different biomedical signals.
2. To apply different methods to analyze and filter the signals.
3. To detect events in signals used for diagnosis.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Understand the origin of different biomedical signals.	Familiarity
CO-2	Able to filter out the noise and artifacts from the medical signals.	Usage
CO-3	Able to extract different events from the signals.	Usage
CO-4	Understand different waveform analyzing methods for medical signals.	Assessment

Course Contents:

Unit	Contents	Lectures required
1	Introduction to Biomedical Signals:- Action potential of neurons, Electrocardiography, Electroencephalogram, Electromyography, Electroretinogram and Electrooculography.	10
2	Filtering for Removal of artefacts: Types of Noise, Power Line and high frequency noise interference, motion artefacts, Filters for removal of interference, Illustration of the Problem with Case Studies.	8
3	Detection of Events: Illustration of the Problem with Case Studies, Derivative based Approaches for QRS detection; Autocorrelation function and Cross- correlation functions for the detection of events in EEG.	8
4	Waveform Analysis: Morphological Analysis of waves, Envelope detection and Analysis; Analysis of activity using Root Mean Square value, Zero-crossing rate, Turns Count, and Form factor.	8
5	Frequency-domain Analysis: Spectral Analysis of biomedical signals, Estimation of PSD; Measures Derived from PSDs.	8
Total lectures		42

Suggested Text Book(s):

1. R. S Khandpur and Raghbir Khandpur: Biomedical Instrumentation, 2nd Ed., McGraw-Hill Education; , 2003.
2. Rangaraj M. Rangayyan, Biomedical Signal Analysis, 2nd Ed., Wiley,2015.

Suggested Reference Book(s):

1. Leslie Cromwell, Fred Weibell J, Erich Pfeiffer. A: Biomedical Instrumentation and Measurements, Prentice-Hall India, 2nd Edition, 1997.
2. John G. Webster: Medical Instrumentation application and design, John Wiley, 3rd Edition, 1997.

Other useful resource(s):

Link to NPTEL course contents: https://nptel.ac.in/courses/108105101/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes(2) -10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Biomedical Signal Processing)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	1	3	2	3	2	2	3	2	2	1	3	2.28
CO-2	3	3	3	3	3	1	1	2	2	2	1	3	2.25
CO-3	3	3	3	3	3	1	1	2	2	2	1	3	2.25
CO-4	3	3	3	3	3	1	1	2	2	2	1	3	2.25
Average	2.75	2.5	3	2.75	3	1.25	1.25	1.25	2	2	1	3	

Industrial Internet of Things

COURSE CODE: 18B1WEC839

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

1. To understand the concepts of Internet of Things.
2. To automate the industrial process through IoT applications.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	To Understand the Characteristics of IoT.	Familiarity
CO-2	To provide the basic knowledge of Network & Communication Aspects of IoT.	Familiarity
CO-3	To Design IoT applications in different domain and be able to analyze their performance.	Usage
CO-4	To Implement basic IoT applications on embedded platform.	Assessment

Course Contents:

Unit	Contents	Lectures required
1.	Introduction to IoT: Defining IoT, Characteristics of IoT, Physical design of IoT, Logical design of IoT, Functional blocks of IoT, Communication models & Application Programming Interfaces (APIs).	6
2.	IoT & M2M: Machine to Machine, Difference between IoT and M2M, Software defined Network.	8
3	Network & Communication Aspects: Wireless medium access issues, MAC protocol survey, Survey routing protocols, Sensor deployment & Node discovery, Data aggregation & dissemination.	8
4	Challenges in IoT: Design challenges, Development challenges, Security challenges, Other challenges.	8
6	Domain specific applications of IoT: Home automation, Industry applications, Surveillance applications, Other IoT applications.	6
7	Developing IoTs: Introduction to different IoT tools, Developing applications through IoT tools, Developing sensor based application through embedded system platform, Implementing IoT concepts.	6
	Total Lectures	42

Suggested Text Book(s):

1. Arshdeep Bahga and Vijay Madisetti, “Internet of Things: A Hands-on Approach”,Universities Press, 1st Edition, 2015.
2. Pethuru Raj and Anupama C. Raman, "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", CRC Press, 1st Edition, 2017.

Suggested Reference Book(s):

1. Antonio Capasso and Giacomo Veneri, “Hands-On Industrial Internet of Things: Create a Powerful Industrial IoT Infrastructure Using Industry 4.0”, Pact Publishing Ltd, UK, 1st edition, 2018.
2. Waltenegus Dargie, Christian Poellabauer, "Fundamentals of Wireless Sensor Networks: Theory and Practice", Wiley-Blackwell, 1st Edition, 2010.

Other useful resource(s):

Link to NPTEL course contents: https://onlinecourses.nptel.ac.in/noc17_cs22/preview

Link to topics related to course: https://onlinecourses.nptel.ac.in/noc19_cs32/preview

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Industrial Internet of Things)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	3	3	3	3	3	3	3	3	3	3	3
CO-2	3	3	3	3	3	3	3	3	3	3	3	3	3
CO-3	3	3	3	3	3	3	3	2	2	2	2	2	2.6
CO-4	3	3	3	3	3	2	3	3	3	3	3	3	2.9
Average	3	3	3	3	3	2.75	3	2.75	2.75	2.75	2.75	2.75	

Wireless Ad Hoc and Sensor Networks

COURSE CODE: 18B1WEC844

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

1. To understand the basic WSN technology and supporting protocols, with emphasis placed on standardization basic sensor systems and provide a survey of sensortechnology.
2. Learn key routing and transport layer protocols for sensor networks, and design requirements.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Understand the basics of wireless sensor and ad-hoc network.	Familiarity
CO-2	To identify communication protocols employed in wireless sensor and ad hoc network.	Assessment
CO-3	To select the appropriate technology to implement a WSN.	Assessment
CO-4	To assess different communication protocols and their usefulness in different applications	Usage

Course Contents:

Unit	Contents	Lectures required
1	Introduction: Wireless sensor and Ad Hoc Networks, Architecture, Self-organizing Behaviour, Practical Implementation Issues, Power Management.	8
2	Layered Protocols Architecture, Physical layer, WSN Coverage & Placement of wireless sensor nodes, Topology Management in Wireless Sensor	8
3	Data link layer, Network layer, Congestion and Flow Control	8
4	MAC and Routing Protocols, Application of MAC and Routing protocols, Cooperation in Ad Hoc Network, MANETs.	9
5	Multicasting in MANETs, Mobility Models, Transport Protocols for MANETs, Opportunistic Mobile Networks, UAV Networks	9
Total lectures		42

Suggested Text Book(s):

1. Savo G Glisic, "Advanced Wireless Networks 4G Technologies", 2nd Edition, John Wiley & Sons, 2006.
2. Yingshu Li, My T. Thai, "Wireless Sensor Networks and Applications". 1st Edition, Springer,2008.
3. Jonathan Loo et.al. , "Mobile Ad Hoc Networks current status and future trends" 1st Edition, CRC Press, 2016.

Suggested Reference Book(s):

1. Stefano Basagni , "Mobile Ad Hoc Networking", 2nd Edition, John Wiley & Sons, 2015,
2. Driss Benhaddou, "Wireless Sensor and Mobile Ad-Hoc Networks", 1st Edition, Springer,2015.
3. A.Goldsmith, "Wireless communication" 1St Edition, CambridgeUniversity Press,2005.

Other useful resource(s):

Link to NPTEL course contents: https://swayam.gov.in/courses/4408-wireless-adhoc-and-sensor-networks

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programmed Outcomes (POs)

Course outcomes (Wireless Ad Hoc and Sensor Networks)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	1	2	2	2	3	1	1	1	1	2	2	3	1.75
CO-2	3	3	2	2	2	2	2	1	2	2	1	2	2
CO-3	3	1	2	1	2	2	2	2	2	3	1	1	1.83
CO-4	3	3	2	2	2	2	1	2	1	2	2	1	1.91
Average	2.5	2.25	2	1.75	2.25	1.75	1.5	1.5	1.5	2.25	1.5	1.75	

Satellite Communication

COURSE CODE: 18B1WEC841 COURSE

CREDITS: 3 CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Basic knowledge of communications Course Objectives:

1. To acquire good knowledge about the components of a satellite communication system.
2. To analyze different methods of satellite access and the applications of satellites.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	To obtain basic knowledge of satellite communication principles.	Familiarity
CO-2	To have a thorough understanding of orbital mechanics and launches for the satellite communication.	Familiarity
CO-3	To understand the basic knowledge of link design of a satellite system.	Assessment
CO-4	To provide better understanding of multiple access systems and earth station technology.	Assessment
CO-5	To prepare students with knowledge in satellite navigation and GPS and satellite packet communications.	Usage

Course Contents:

Unit	Contents	Lectures required
1	Introduction : Origin of Satellite Communication, Historical Back-ground, Basic Concepts of Satellite Communication, Frequency allocations for Satellite Services, Applications, Future Trends of Satellite Communication.	2
2	Orbital mechanics and launchers: Kepler's laws, Newton's law, Orbital Mechanics, Look Angle determination, Orbital perturbations, Orbit determination, launches and launch vehicles, Orbital effects in communication systems performance.	7
3	Satellite systems: Attitude and orbit control system, telemetry, tracking, Command and monitoring, power systems, communication subsystems, Satellite antenna Equipment reliability and Space qualification.	6
4	Earth station technology and Link design: Introduction, Transmitters, Receivers, Antennas, Tracking systems, Terrestrial interface, Primary power test methods. Basic transmission theory, system noise temperature and G/T ratio, Design of down links, up link design, Design of satellite links for specified C/N, System design example.	6
5	Multiple Access: Frequency Division Multiple Access (FDMA) – Intermodulation Calculation of C/N, Time Division Multiple Access (TDMA) – Frame Structure, Burst Structure, Satellite Switched TDMA, On-board Processing, Demand Assignment Multiple Access (DAMA) — Types of Demand Assignment, Characteristics, CDMA Spread Spectrum Transmission and Reception.	9
6	Low earth orbit and geo-stationary satellite systems: Orbit consideration, coverage and frequency considerations, Delay & Throughput considerations, System considerations, Operational NGSO constellation Designs	6
7	Satellite navigation and the global positioning system: Radio and Satellite Navigation, GPS Position Location principles, GPS Receivers and codes, Satellite signal acquisition, GPS Navigation Message, GPS signal levels, GPS receiver operation, GPS C/A code accuracy, Differential GPS.	6
Total lectures		42

Suggested Text Book(s):

1. Timothy Pratt, Charles Bostian and Jeremy Allnutt, "Satellite Communications", 2nd Edition , John Wiley & Sons, 2002.
2. Dennis Roddy, "Satellite Communication", 4th Edition, Mc Graw Hill International, 2006.

Suggested Reference Book(s):

1. M.Richharia, "Satellite Communication Systems-Design Principles", 1st Edition, Palgrave, Macmillan 2003.
2. Wilbur L. Pritchard, Robert A Nelson and Henri G.Suyderhoud, "Satellite Communications Engineering", 2nd Edition, Pearson Publications, 2003.

Other useful resource(s):

Link to NPTEL course contents: https://nptel.ac.in/syllabus/117105131/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Satellite Communications)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	2	1	1	1	2	1	2	1.7
CO-2	2	3	2	3	2	2	2	1	1	2	1	3	2.0
CO-3	3	3	3	3	3	2	1	1	2	2	2	2	2.3
CO-4	2	2	2	2	2	3	2	1	1	3	2	2	2.0
CO-5	3	2	3	2	2	2	1	1	1	2	1	2	1.8
Average	2.4	2.4	2.4	2.4	2.2	2.2	1.4	1.0	1.2	2.2	4	2.20	

Pavement Analysis and Design

COURSE CODE:18B1WCE632

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

1. To develop skills in conducting analysis of pavements by calculating the response due to vehicular loading
2. To perform design of rigid and flexible pavements based on traffic and environmental factors
3. To develop skills in engineering economics (especially life-cycle cost calculations for alternative designs)
4. To develop basic understanding of the principles of pavement management

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	The students will have the opportunity to develop several designs of pavement structures throughout the semester.	Familiarity
CO-2	Through discussion of the topic of pavement management, the students gain an appreciation for the constantly changing nature of engineering decision-making and the impacts of various decisions on an infrastructure network.	Assessment
CO-3	Students will analyze traffic and geotechnical data from real-life projects and theoretical examples.	Assessment
CO-4	The students are required to complete a semester design problem and present their findings to the instructor and other students.	Assessment

Course Contents:

Unit	Contents	Lectures required
1	**Advanced Pavement materials**: Waste materials: types, uses in flexible pavement, effect and benefit of utilization of waste material, advance pavement material, Design of bituminous mixes by Marshal method, modified Hubbard –field method, Hveem method, etc.	8
2	**Flexible pavement design**: Basis of pavement design, Development of various design methods for Highway and Airport Pavements.	8

Approved in Academic Council held on 25.10.2018

	Layered system concept, Classical methods, Mechanistic-Empirical Method and various damage models, pavement failure study: factors responsible for pavement failure, stress-strain behavior, Current practices in India and across the world.	
3	**Rigid pavement design**: Analysis and design parameters, design of slab, spacing of joints, dowel bars, tie bars and joint details, pavement failure study: factors responsible for pavement failure, stress-strain behavior.	**6**
4	**Overlays**: Types of overlays, Overlay design, Pavement Evaluation	**6**
5	**Design Software**: FPAVE, MXRoads, etc.	**8**
Total lectures		**42**

Suggested Text Book(s):

1 Yoder, E.J. and Witczak, M.W., ―Principles of Pavement Design 2nd Ed‖, John Wiley & Songs, Inc. (1975)

2 O'Flaherty, A. Coleman, ―Highways : the Location, Design, Construction and Maintenance of Road Pavements‖, 4th Ed., Elsevier (2006)

3 Fwa, T.F., ―The Hand Book of Highway Engineering‖, CRC Press Taylor &Francies Group, 2006.

4 Khanna, S.K. and Justo, C.E.G., ―Highway Engineering Nem Chand Jain & Bros, 2005.

5 Papagiannakis, A.T. and Masad, E.A., ―Pavement Design and Materials, John Wiley & Sons Inc, 2008.

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes(2)-10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course Outcomes (Pavement Analysis and Design)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	3	2	2	2	3	2	2	2	2	**2.17**
CO-2	2	3	2	3	3	1	2	2	2	2	2	2	**2.17**
CO-3	2	2	2	2	3	1	2	1	2	2	2	2	**1.92**
CO-4	2	3	2	3	2	2	2	1	2	3	2	2	**2.17**
Average	**2**	**2.5**	**2**	**2.75**	**2.5**	**1.5**	**2**	**1.75**	**2**	**2.25**	**2**	**2**	

Phytopharmaceuticals and Biologicals

COURSE CODE: 18B1WBT531

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Basic understanding of biology

Course Objectives:

a. The objective of the course is to develop an understanding and basic knowledge on Indian medicinal herbs, its commercial value, quality control and industrial standards for commercialisation of phytopharmaceuticals and biologicals.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Able to understand pharmacopoeial standards of ayurvedic products	Familiarity
CO-2	Able to understand the phytopharmaceuticals, monographs and quality control of medicinal herbs	Usage
CO-3	Able to understand the extraction and evaluation process of phytopharmaceuticals	Technical
CO-4	Able to understand pharmacopoeial standards of Indian Pharmacopoeia	Familiarity
CO-5	Able to understand the monographs, specifications and quality control of biologicals	Usage

Course Contents:

Unit	Contents	Lectures required
1	Intoduction to phytopharmaceuticals – medicinal herbs & its importance and biologicals. Over view of Ayurvedic and Indian Pharmacopoeia	**4**
2	Pharmacopoeial standards of Ayurvedic (Used by manufacturers, regulators and other stakeholders for quality control of medicinal herbs and finished products against internationally recommended specifications).	**7**
3	Monographs of medicinal herbs, specifications and standards for identification, evaluation, processes and clinical applications	**8**
4	Evaluation of physiochemical parameters of herbal drugs, extraction, Identification & Assay of Herbals Drugs	**6**
5	Pharmacopoeial standards of Indian Pharmacopoeia (Used by manufacturers, regulators and other stakeholders for quality control of active pharmaceutical ingredients (APIs) and finished products against internationally recommended specifications).	**3**
6	Monographs on Blood and Blood related products, Monographs on Human Vaccines (The specifications cover the various tests for critical quality parameters of the vaccine, procedures and acceptance criteria)	**7**
	Monographs of Erythropoietin Injection, Interferon Injection, streptokinase	

7	solution, Human Insulin, etc. Bacterial Endotoxin Test, Sterility Test, Test for Microbial Contamination, etc.	**7**
Total lectures		**42**

Suggested Text Book(s):

1. The Ayurvedic Pharmacopoeia Of India, First Edition, Published By Pharmacopoeia Commission For Indian Medicine & Homoeopathy Ghaziabad (2016)
2. Indian Pharmacopoeia published by the Indian Pharmacopoeia Commission (IPC)

EvaluationScheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment, Quizzes&Attendance

Course Outcomes (COs) contribution to the ProgrammeOutcomes(POs)

Course outcomes (Phytopharmaceuticals and Biologicals)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	2	2	2	2	2	1	2	1.9
CO-2	2	2	2	2	2	1	1	2	2	2	1	2	1.75
CO-3	2	2	2	2	2	1	1	1	2	2	2	2	1.75
CO-4	2	2	2	2	2	1	1	1	2	2	1	2	1.6
CO-5	2	2	2	2	2	1	1	2	2	2	1	2	1.75
Average	2.0	2.0	2	2	2	1.25	1.25	1.5	2.0	2	1.25	2.0	

Principles of Communication Systems

COURSE CODE: 18B1WEC635 COURSE

CREDITS: 2 CORE/ELECTIVE: ELECTIVE

L-T-P: 2-0-0

Pre-requisite: Signals & Systems. Course

Objectives:

1. To make the students familiar with the constituent elements of the communication systems such as transmitter, receiver and channel with their features.
2. To make students understand the various modulation techniques.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	To be familiar with the need of modulation and various types of modulation.	Familiarity
CO-2	Assess and evaluate different analog and angle modulation and demodulation techniques.	Assessment
CO-3	Develop an ability to compare and contrast the strengths and weaknesses of various communication systems.	Assessment
CO-4	To understand the need of sampling and sampling theorem.	Assessment
CO-5	To understand the basics of various digitization techniques like PCM, DPCM, DM, ADM.	Usage

Course Contents:

Unit	Contents	Lectures required
1	Introduction: Basic elements of communication system; Analog and digital signals, bandlimited signals and systems, bandwidth.	3
2	Amplitude Modulation: AM Signal and Spectra, AM Current and Power Relation, AM generation and Demodulation, Double Side-Band Suppressed Carrier System (DSB-SC)'s Need, Generation and Demodulation, Single Side-Band Suppressed Carrier System (SSB-SC)'s Need, Generation and Demodulation.	9
3	Angle Modulation: Concept of Frequency and Phase modulation, Narrowband and Wideband FM, Carson's Rule of bandwidth, FM Generation and Detection, Comparison of AM and FM. .	8
4	Receivers and Multiplexing Techniques: TRF Receiver, Superheterodyne Receiver, Frequency Division Multiplexing (FDM) and Time Division Multiplexing (TDM).	2
5	Sampling and Pulse Modulation Techniques: Sampling Theorem with proof, Reconstruction of Signal from Sampled Signal, Pulse Amplitude Modulation (PAM), Pulse Width Modulation (PWM), Pulse Position Modulation (PPM).	5
6	Digitization Techniques and Line Coding: Basics of Quantization, Pulse Code Modulation (PCM), Differential PCM, Delta Modulation (DM), Adaptive Delta Modulation (DM).	3
Total lectures		30

Suggested Text Book(s):

1. B P Lathi and Zhi Ding, "Modern Digital and Analog Communication", 4th Ed., Oxford University Press, 2010.
2. R P Singh and S D Sapre, "Communication Systems: Analog and Digital", 3nd Ed., Tata McGraw-Hill Publishing Company Ltd., 2012.

Suggested Reference Book(s)

1. Simon Haykin, "Communication Systems", 4th Ed., John Wiley, 2001.

Other useful resource(s):

1. Link to NPTEL course contents: https://nptel.ac.in/courses/108104091/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (1) - 5 Quizzes (2) - 15 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course Outcomes (Principles of Communication Systems)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	3	3	1	2	1	2	1	2	2	3	2.17
CO-2	3	3	3	3	3	2	2	2	1	1	1	3	2.25
CO-3	3	3	3	3	2	3	3	2	1	2	3	3	2.58
CO-4	3	3	3	2	2	1	1	1	1	2	3	3	2.08
CO-5	3	3	3	2	3	2	1	2	1	2	3	3	2.33
Average	3.00	3.00	3.00	2.60	2.20	2.00	1.60	1.80	1.00	1.80	2.40	3.00	

Principles of Communication Systems Lab

COURSE CODE: 18B1WEC672

COURSE CREDITS: 1

CORE/ELECTIVE: ELECTIVE

L-T-P: 0-0-2

Pre-requisite: None.

Course Objectives:

To enhance the understanding of communication systems and devices.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO1	To understand the fundamentals of designing of a filter.	Familiarity
CO2	To design a laboratory set up for the understanding of Amplitude modulation and Angle modulation.	Usage
CO3	To design and understand the importance of Sampling.	Usage
CO4	To understand the practical implementation of PAM, PWM, PPM.	Usage
CO5	To understand transmission line encoding.	Usage
CO6	To practically design digitization techniques like PCM, DM.	Usage

List of Experiments:

S. No	Description	Hours
1	To design and obtain the frequency response of Low pass filter of cut- off frequency 1 KHz.	2
2	To design and obtain the frequency response of High pass filter of cut- off frequency 1 KHz.	2
3	To perform Amplitude modulation and its demodulation using Envelope detector. Measure the modulation index.	2
4	To perform Frequency modulation and its demodulation. Measure the modulation index.	2
5	To design Sample and Hold circuit.	2
6	To perform Pulse Amplitude modulation (PAM).	2
7	To perform Pulse Width modulation (PWM).	2
8	To perform Pulse Position modulation (PPM).	2
9	To perform Line coding techniques.	2
10	To perform Delta modulation.	2
11	To perform Time division multiplexing.	2
12	To perform Pulse code modulation and its demodulation.	2
Total Lab hours		24

Suggested/Resources:

1. B P Lathi and Zhi Ding, "Modern Digital and Analog Communication", 4th Ed., Oxford University Press, 2010.
2. R P Singh and S D Sapre, "Communication Systems: Analog and Digital", 3nd Ed., Tata McGraw-Hill Publishing Company Ltd., 2012.

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Attendance	15 Marks
4	Lab Assessment	45 Marks
	Total	100 marks

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Average
CO1	3	3	3	3	1	2	1	2	1	2	2	3	2.17
CO2	3	3	3	3	3	2	2	2	1	1	1	3	2.25
CO3	3	3	3	3	2	3	3	2	1	2	3	3	2.58
CO4	3	3	3	2	2	1	1	1	1	2	3	3	2.08
CO5	3	3	3	2	3	2	1	2	1	2	3	3	2.33
CO6	3	3	3	2	2	2	1	2	1	2	3	3	2.25
Average	3	3.00	3.00	2.50	2.17	2.0	1.5	1.83	1.00	1.83	2.50	3.00	

Parallel and Distributed Algorithms

COURSE CODE: 18B1WCI632

COURSE CREDITS: 2

CORE/ELECTIVE: ELECTIVE

L-T-P: 2-0-0

Pre-requisites: You should be comfortable programming in C and /or Java in particular. No prior knowledge of parallel computing is required. Good knowledge of undergraduate level algorithms, data structures, operating system and computer architecture.

Course Objectives:

1. To acquaint students with the basic concepts of parallel and distributed computing.
2. To learn general principles of parallel and distributed algorithms
3. To analyse their time complexity.
4. To acquaint students with various parallel and distributed approaches of problem solving.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	To reason about ways to parallelize a problem and be able to evaluate a parallel platform for a given problem.	Familiarity
CO-2	To understand and explore the concepts with programming with MPI and Map Reduce/Hadoop.	Assessment
CO-3	To demonstrate the general concepts on Cloud computing, grid computing, and peer-to-peer systems.	Usage
CO-4	To become familiar with evaluation of online social networks and their potential.	Usage

Course Contents:

Unit	Contents	Lectures required
1	**Introduction: The power and potential of parallelism** The power and potential of parallelism, purpose of using parallelism, different parallel architecture, Reasoning about performance of parallel programs.	6
2	**Data, Task Parallelism and Java Multithreading** Introduction of data and task parallelism, Independent parallelism, Introduction to Java multithreading, Fork-join parallelism, Analyze fork and join parallelism, parallel prefix, parallel pack	6
3	**Mutual exclusion, Deadlocks and Parallel Computational Models** Concurrency, STM, Mutual exclusion, locks, Deadlocks, race condition, Read/write locks, condition variables, Flynn‟s Taxonomy, PRAM, EREW, CREW, ERCW, CRCW, Simulating CRCW, CREW and EREW, PRAM algorithms. Parallel Programming Models, PVM, MPI Paradigms	6
4	**Parallel Algorithms and Programming Languages** Parallel Programming Language, Brent‟s Theorem, Simple parallel programs in MPI environments, Parallel algorithms on network, Addition of Matrices, Multiplication of Matrices., Parallel quick sort, Synchronizing shared data structure, Shared memory	6
5	**Distributed System Model and Cases** Distributed system models, Inter process communication, Message passing, Message passing algorithm, Distributed synchronization, Consistency,	8

	replication, Cluster computing, MapReduce, Distributed storage, Wide area computing, Distributed hash table, Peer-to-peer systems. Cases a) Parallel computing algorithms and representative programming models, b) Convergence of parallel, distributed and cloud computing, c) Cluster Computing, its performance model and system evolution.	
Total lectures		**32**

Suggested Text Book(s):

1. "A. Grama, A. Gupta, G. Karypis and V. Kumar. Introduction to Parallel Computing (2nd edition), Addison Wesley (2002), ISBN 0-201-64865-2.
2. H. El-Rewini and T.G. Lewis. Distributed and Parallel Computing, Manning (1997), ISBN 0-13-795592-8.
3. I. Foster. Designing and Building Parallel Programs, Addison Wesley (1995), ISBN 0-201-57594-9.

Suggested Reference Book(s):

1. Kai Hwang and Zhiwei Xu. Scalable Parallel Computing, McGraw Hill (1998), ISBN 0-07-031798-4.
2. Michael J. Quinn. Parallel Programming in C with MPI and OpenMP, McGraw Hill (2003), ISBN 0-07-282256-2.
3. Barry Wilkinson and Michael Allen. Parallel Programming: Techniques and Applications Using Networked Workstations and Parallel Computers (2nd Edition), Prentice Hall PTR (2005), ISBN 0-13-140563-2

Other useful resource(s):

1. Link to NPTEL course contents: https://nptel.ac.in/courses/106102114/
2. Link to topics related to course: https://nptel.ac.in/courses/106106107/
   i. https://nptel.ac.in/courses/106106112/
   ii. https://nptel.ac.in/courses/106106112/2
   iii. https://nptel.ac.in/courses/106106112/3
   iv. https://nptel.ac.in/courses/106106112/3

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment		Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Parallel and Distributed Algorithms)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	1	1	2	**1.6**

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CO-2	2	3	3	3	3	1	1	1	2	2	1	1	**1.9**
CO-3	2	3	3	3	3	1	1	1	2	2	1	1	**1.9**
CO-4	2	3	3	3	2	1	1	1	1	3	2	2	**2**
Average	**2**	**2.8**	**2.8**	**2.8**	**2.5**	**1**	**1**	**1**	**1.8**	**2**	**1.3**	**1.5**	

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Parallel and Distributed Algorithms Lab

COURSE CODE: 18B1WCI672

COURSE CREDITS: 1

CORE/ELECTIVE: ELECTIVE

L-T-P: 0-0-2

Pre-requisite: None

Course Objectives:

1. To acquaint students with the basic concepts of parallel and distributed computing.
2. To learn general principles of parallel and distributed algorithms
3. To analyse their time complexity.
4. To acquaint students with various parallel and distributed approaches of problem solving.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	To reason about ways to parallelize a problem and be able to evaluate a parallel platform for a given problem.	Familiarity
CO-2	To understand and explore the concepts with programming with MPI and MapReduce/Hadoop.	Assessment
CO-3	To demonstrate the general concepts on Cloud computing, grid computing, and peer-to-peer systems.	Usage
CO-4	To become familiar with evaluation of online social networks and their potential.	Usage

List of Experiments:

S. No.	Description	Lab Hours
1	Design, develop a program to implement task parallelism with Java multithreading.	**4**
2	Design, develop a program to implement Fork-join parallelism and Analyse fork and join parallelism, parallel prefix, parallel pack.	**4**
3	Design, develop a program for PRAM algorithms.	**4**
4	Design, develop a program to implement Parallel Programming Models, PVM, MPI Paradigms.	**4**
5	Design, develop a program to implement Brent"s Theorem.	**4**
6	Design, develop a program to solve base on MapReduce.	**8**
Total Lab Hours		**28**

Minor Project(s) – (Only for 2 credit lab)

Create a solution for a Complex Engineering Problem by using Apache Hadoop Map/Reduce. Solution should be distributed in nature or use a distributed programming paradigm in its solution domain.

Suggested Books/Resources:

1. "A. Grama, A. Gupta, G. Karypis and V. Kumar. Introduction to Parallel Computing (2nd edition), Addison Wesley (2002), ISBN 0-201-64865-2.
2. H. El-Rewini and T.G. Lewis. Distributed and Parallel Computing, Manning (1997), ISBN 0-13-795592-8.
3. Foster. Designing and Building Parallel Programs, Addison Wesley (1995), ISBN0-201-57594-9.

4. Kai Hwang and Zhiwei Xu. Scalable Parallel Computing, McGraw Hill (1998), ISBN 0-07-031798-4.
5. Michael J. Quinn. Parallel Programming in C with MPI and OpenMP, McGraw Hill (2003), ISBN 0-07-282256-2.
6. Barry Wilkinson and Michael Allen. Parallel Programming: Techniques and Applications Using Networked Workstations and Parallel Computers (2nd Edition), Prentice Hall PTR (2005), ISBN 0-13-140563-2
7. Link to NPTEL course contents: https://nptel.ac.in/courses/106102114/
8. Link to topics related to course: https://nptel.ac.in/courses/106106107/
   i. https://nptel.ac.in/courses/106106112/
   ii. https://nptel.ac.in/courses/106106112/2
   iii. https://nptel.ac.in/courses/106106112/3
   iv. https://nptel.ac.in/courses/106106112/3

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Attendance	15 Marks
4	Lab Assessment	45 Marks
	Total	100 marks

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	Average
CO1	3	3	3	3	2	2	1	1	1	1	1	1	**1.9**
CO2	3	3	3	3	3	1	1	1	1	1	1	3	**2**
CO3	3	3	2	3	2	3	2	1	1	1	2	1	**2**
CO4	3	3	3	2	3	2	1	1	1	1	1	1	**1.8**
CO5	2	2	3	3	3	3	1	1	1	1	1	1	**1.8**
CO6	2	3	3	3	2	2	2	2	2	2	2	2	**2.3**
Average	**2.7**	**2.8**	**2.8**	**2.8**	**2.5**	**2.2**	**1.3**	**1.2**	**1.2**	**1.2**	**1.3**	**1.6**	

Digital Image Processing Lab

Approved in Academic Council held on 25.10.2018

Principles of Digital Signal Processing Lab

COURSE CODE: 18B17EC571

COURSE CREDITS: 1

CORE/ELECTIVE: CORE

L-T-P: 0-0-2

Pre-requisite: None

Course Objectives:

1. To provide a thorough understanding and analysis of digital signal processing systems using LabVIEW.
2. To familiar with usage of code compressor studio.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO1	Understand the basics of Lab VIEW Programming and code compressor studio.	Familiarity
CO2	Generate the discrete time signals using sampling and conversion of analog signals in to digital signals.	Familiarity
CO3	Analyze the FFT Algorithm based frequency domain representation.	Usage
CO4	Design the FIR and IIR filter for specified parameters.	Usage
CO5	Apply the adaptive filtering for systems identification.	Assessment
CO6	Perform the linear and circular convolution using DSP kit to get the LTI system response..	Assessment

List of Experiments

S. No	Description	Hours
1	Getting Familiar with LabVIEW.	2
2	Generate a discrete signal by sampling a sinusoidal signal and I investigate the aliasing effect.	2
3	Convert analog signal to digital signal (A/D) and digital signal to analog signal (D/A) using LabVIEW	2
4	Design FIR filter using LabVIEW to meet specifications on their frequency response using window design.	2
5	Design IIR Filter using LabVIEW to meet specifications on their frequency response using the bilinear transformation.	2
6	Use LabVIEW to analyze and display signals in the frequency- domain using the FFT algorithm.	2
7	Design an adaptive filter for system identification using LabVIEW.	2
8	Getting familiar with code compressor studio.	2
9	Perform and verify linear convolution of two signals using DSP Kit.	2
10	Perform and verify circular convolution of two signals using DSP Kit.	2
11	Binary Phase Shift Keying using LabVIEW.	2
12	Design of FIR Filter by interfacing MATLAB with code composer studio.	2
Total Lab hours		24

Suggested/Resources:

1. T. H Cormen, C E Leiserson, R L Rivest and C Stein: Introduction to Algorithms, 3rd Edition, Prentice-Hall of India, 2010.
2. Kenneth A. Berman, Jerome L. Paul: Algorithms, Cengage Learning, 2002.

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3. Ellis Horowitz, Sartaj Sahni, S.Rajasekharan: Fundamentals of Computer Algorithms, 2nd Edition, Universities press, 2007
4. https://nptel.ac.in/courses/106104019/26
5. https://nptel.ac.in/courses/106104019/2Ev

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Attendance	15 Marks
4	Lab Assessment	45 Marks
	Total	100 marks

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Average
CO1	3	3	3	3	2	2	1	1	1	1	1	1	1.83
CO2	3	3	3	3	3	1	1	1	1	1	1	3	2.00
CO3	3	3	2	3	2	3	2	1	1	1	2	1	2.00
CO4	3	3	3	2	3	2	1	1	1	1	1	1	1.83
CO5	2	2	3	3	3	3	1	1	1	1	1	1	1.83
CO6	2	3	3	3	2	2	2	2	2	2	2	2	2.25
Average	2.67	2.83	2.80	2.80	2.60	2.20	1.20	1.00	1.00	1.00	1.20	1.40	

Python Lab

COURSE CODE: 18B17EC474

COURSE CREDITS: 1

CORE/ELECTIVE: CORE

L-T-P: 0-0-2

Pre-requisite: None

Course Objectives:

1. Develop problem solving ability using python.
2. Learn python programming approach to solve engineering problems.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO1	To understand the python program development environment, debugging, and executing.	Familiarity
CO2	To understand the usage of control statements in python program.	Usage
CO3	To practice programming in python for solving some simple problems leading to specific applications.	Usage
CO4	Able to design a project on python.	Assessment

List of Experiments

S.No	Description	Hours
1	Introduction to Python, Python IDE, Variable types and basic operators in Python.	2
2	Programs on conditional statements using if statement, if-else statement, and nested if statement.	2
3	Programs on loop control statements using while loop, for loop, and nested loop.	2
4	Programs on string handling with and without importing toolbox.	2
5	Usage of list and tuples in the program.	2
6	Programs for creating and using dictionaries.	2
7	Definition, declaration, and call of functions in python.	2
8	Programs using classes and objects.	2
9	Program on basic file handling operations like opening and closing of a file, creating a text file, copy the content of one file into another.	2
10	Handling of exceptions in python.	2
11	Programs for sorting the sequence of numbers using different sorting algorithms.	2
12	Mini project.	2
Total Lab hours		24

Suggested/Resources:

1. A N Kamthane and A A Kamthane: Programming and Problem Solving with Python, 1st Edition, McGraw Hill Education, 2017.
2. A Downey: Learning with Python, 1st Edition, Dreamtech Press, 2015.
3. M C Brown: Python The Complete Reference, 1st Edition, McGraw Hill Education, 2001.

Approved in Academic Council held on 25.10.2018

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Attendance	15 Marks
4	Lab Assessment	45 Marks
	Total	100 marks

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Average
CO1	3	3	1	1	2	2	1	1	1	1	1	3	1.67
CO2	3	3	3	3	3	2	1	1	1	1	1	3	2.08
CO3	3	3	2	3	3	2	1	1	1	1	2	3	2.08
CO4	3	3	3	3	3	2	1	1	1	1	3	3	2.25
Average	3.00	3.00	2.25	2.50	2.75	2.00	1.00	1.00	1.00	1.00	1.75	3.00	

Engineering Physics-II

COURSE CODE: 18B11PH211

COURSE CREDITS: 3

CORE/ELECTIVE: CORE

: 3-0-0

Pre-requisite: None

Course Objectives:

1. To offer a broad aspect of those areas of Physics which are specifically required as an essential background to engineering students for their studies in higher semesters.
2. To enable the students to get better understanding about solid state physics and its applications in engineering.
3. To familiarize students about electromagnetism and its applications in engineering.
4. To enable the students to get better understanding about statistical physics and its applications in engineering.
5. To familiarize students with optical fibers communication.
6. At the conclusion of the course, the ability of students should have enhanced to think logically about the problems of science and technology and obtain their solutions.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	To learn the fundamentals of vector calculus and its applications in electrostatics	Familiarity
CO-2	Knowledge of, physical interpretation, and ability to apply Maxwell's equations to determine field waves, potential waves, energy ,charge conservation conditions and other diverse engineering problems.	Familiarity/Assesment
CO-3	Able to distinguish Step Index, Graded index fibers and compute mode volume and Implementation of numerical methods for calculating the design parameters of optical fiber.	Familiarity/Problem Solving
CO-4	To understand the basics of statistical distributions and use Maxwell-Boltzmann distribution, Fermi-Dirac and Bose-Einstein distributions to solve problems in some physical systems	Familiarity/Problem Solving
CO-5	To analyze atomic structure, Crystal structure, Crystal axes and planes, X-ray diffraction data and effect of energy bands on electronic behavior of solids.	Analytical Skills/ Familiarity
CO-6	To understand the concepts of modern solid state physics ,various properties of semiconductors and apply Hall effect to calculate allied parameters of semiconductors	Familiarity/ Usage

Course Contents:

Unit	Contents	Lectures required
1	**Electromagnetism:** Basic knowledge of fields, gradient, divergence and curl, Coulomb's law and related numerical, electric flux, Gauss's law for the charge inside and outside the Gaussian surface, applications of Gauss law: spherical and cylindrical symmetries, electric field due to charged conductor, force per unit area on the surface of the charged conductor, treatment of electrostatic problems by solution of Laplace and Poisson's equations. Biot Savart law,	12

	Ampere's law, Maxwell's equations in free space and dielectric media, energy in electromagnetic waves (Poynting vector and Poynting theorem), plane electromagnetic waves in free space, transverse nature, wave impedance and energy flow, energy density and energy flux (Poynting vector) in an electromagnetic field, radiation pressure.	
2	**Statistical Physics & Applications:** Introduction, macrostates, microstates, thermodynamic probability, distribution of n-particles in k-cells, phase space, minimum volume, classical and quantum statistics: common approach to three statistics, Maxwell-Boltzmann (ideal gas), Bose-Einstein (photon gas), Fermi-Dirac distributions (electron gas), Compton effect.	**10**
3	**Optical Fiber Communication:** Light propagation in fibers, Step index and Graded Index fibers, Numerical Aperture and Attenuation, Single and Multimode fibers and their propagation characteristics, Fiber losses and optical fiber applications.	**4**
4	**Solid State Physics:** Basic ideas of bonding, ionic bonding, covalent bonding (hybridization), metallic bonding, dispersion bonds, dipole bonds, hydrogen bonds, Lattice points and space lattice, basis and crystal structure, unit cell and primitive cell, seven crystal systems and fourteen Bravais space lattice, coordination number, nearest neighbour distance, atomic radius, atomic packing factor in crystal structure, calculation of lattice constant, lattice planes and Miller indices, separation between lattice planes. X-ray diffraction, Bragg's law of X-ray diffraction, Bragg's x-ray spectrometer, powder crystal method, rotating crystal method. Electronic conduction in metals, classical free electron theory, quantum theory of free electrons, band theory of solids, distinction between metals, semiconductors and insulators, intrinsic and extrinsic semiconductors, carrier concentration in thermal equilibrium in intrinsic semiconductor, Fermi level and energy band diagram in intrinsic semiconductor, energy band diagram and Fermi level in extrinsic semiconductors, effect of temperature on extrinsic semiconductor, electrical conductivity of intrinsic semiconductor and extrinsic semiconductor, Hall effect, allied parameters and its applications.	**16**
Total lectures		**42**

Suggested Text Book(s):

1. David J Griffiths, Introduction to Electrodynamics, Eastern Economy Editions, PHI, 4th edition (2012).
2. Brij Lal, N Subrahmanyam and P.S. Hemne, Heat Thermodynamics and Statistical Physics, S. Chand, 3rd edition (2012).
3. Gerd Keiser, Optical Fiber Communication, Tata McGraw-Hill Education Pvt. Ltd., 5th edition (2013).
4. S. O. Pillai, Solid State Physics, New age international publishers, 7th edition (2016).

Suggested Reference Book(s):

1. Charles Kittel, Introduction to Solid State Physics. John Wiley & Sons, 8th edition (2005).
2. Ghatak Ajoy, Thyagarajan, Introduction to Fiber Optics, Cambridge University Press (2006).
3. Silvio R A, Salinass, Introduction to Statistical Physics, Springer Verlag (2004).
4. Lakhanpal R C, Modern Approach to Statistical Physics and Thermodynamics, Modern Publishers (2003).

Other useful resource(s):

1. Link to topics related to course:
   i. https://nptel.ac.in/courses/115101004/
   ii. https://nptel.ac.in/courses/115101005/
   iii. https://nptel.ac.in/courses/115105099/
   iv. https://nptel.ac.in/courses/122101002/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Engineering Physics-II)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	2				2		2	**2**
CO-2	2	3	3	3	3	2				2		2	**2.5**
CO-3	3	3	3	2	3	2				2		2	**2.5**
CO-4	2	3	3	3	2	2				3		3	**2.6**
CO-5	3	3	3	3	2	1				3		3	**2.6**
CO-6	3	3	3	3	2	1				3		3	**2.6**
Average	**2.5**	**2.8**	**2.8**	**2.7**	**2.3**	**1.7**				**2.5**		**2.5**	

Engineering Physics Lab-II

COURSE CODE: 18B17PH271

COURSE CREDITS: 1

CORE/ELECTIVE: CORE

: 0-0-2

Pre-requisite: None

Course Objectives:

1. The Art of Experimentation: The introductory laboratory engages each student in significant experiences with experimental processes, including some experience in investigation.
2. Experimental and Analytical Skills: The laboratory help the student develop a broad array of basic skills and tools of experimental physics and data analysis.
3. Conceptual Learning: The laboratory help student's to understand basic physics concepts.
4. Understanding the Basis of Knowledge in Physics: The laboratory help students understand the role of direct observation in physics and to distinguish between inferences based on theory and the outcomes of experiments.
5. Developing Collaborative Learning Skills: The laboratory helps students to develop collaborative learning skills that are vital to success in many lifelong endeavors.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO1	To Understand different aspects of magnetism and semi conductive properties of materials and their use in design of various devices.	Familiarity
CO2	To helps the students to understand the concepts of light propagation in optical fiber and introduce them to various losses in optical fiber communication.	Familiarity and Assessment
CO3	To demonstrate the scientific results based on observation.	Assessment and usage
CO4	Scientific discussion for clear and concise conclusion on particular scientific results.	Assessment and usage
CO5	To develop collaborative learning skills	Assessment and usage

List of Experiments:

S.No	Description	Hours
1	To determine the numerical aperture, of an optical fibre using LED as a light source.	**2**
2	To determine the attenuation coefficient, losses of an optical fiber	**2**
3	To measure resistivity of semiconductor using four probe methods.	**2**

4	To measure energy band gap of the Ge crystal using four probe methods and compare with optical band gap.	**2**
5	To study Hall effect in semiconductor and determination of its allied parameters.	**2**
6	To determine the carrier concentration and type of doping using hall coefficient.	**2**
7	To calculate the e/m ratio for an electron using Thomson method/Bar magnet method	**4**
8	To study magnetostriction in magnetic materials using He-Ne laser.	**4**
9	To study the coercivity, saturation magnetization, retentivity of given materials.	**4**
10	Experimental Determination of Planck's constant using Light Emitting Diodes (LEDs) and Photoelectric Effect.	**4**
Total Lab hours		**28**

Suggested/Resources:

1. S. P. Singh, Advanced Practical Physics,Pragati Prakashan, Vol. 1 (2013).
2. C. L. Arora, Practical Physics, S. Chand Company Limited, 20th edition (2004).
3. N. Subrahmanayam, Brij Lal and M.N. Avadhanulu, A Text Book of Optics, S. Chand (2012)
4. Ajoy Ghatak, Optics, Tata McGraw Hill, 5th addition, (2012)
5. F.A. Jenkins and H.E. White, Fundamentals of Optics, McGraw-Hill (1981).
6. Dabir S. Viswanath, Tushar Ghosh, Dasika H.L. Prasad, Nidamarty V.K. Dutt, Kalipatnapu Y. Rani , Viscosity of Liquids: Theory, Estimation, Experiment, and Data , Springer (2007).

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Attendance	15 Marks
4	Lab Assessment	45 Marks
	Total	100 marks

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Average
CO1	3	3	3	3	2	2	1	1	3	1	1	1	**2.00**
CO2	3	3	3	3	2	2	1	1	3	1	1	1	**2.00**
CO3	3	3	3	3	2	2	1	1	3	1	1	1	**2.00**
CO4	2	2	2	2	2	2	1	1	1	1	1	1	**1.5**
CO5	2	2	2	2	2	2	1	1	1	1	1	1	**1.5**
Average	**2.6**	**2.6**	**2.6**	**2.6**	**2.0**	**2.0**	**1.0**	**1.00**	**2.2**	**1.00**	**1.0**	**1.0**	

PROJECT MANAGEMENT AND ENTREPRENEURSHIP

Course Objectives: The purpose of this course is to lay the foundation for a firm understanding of project management concepts and principles and to acquaint students with the complexity and challenge of managing public or private projects with stringent schedules and limited resources. Students will gain a sound understanding of project management concepts, relevant tools and techniques. Furthermore, the students are introduced to basic entrepreneurship concepts and framework. Subsequently, they can develop and systematically apply an entrepreneurial way of thinking that will allow them to identify and create business opportunities of commercial value.

Learning Outcomes: At the completion of the course, the learner should be able to:

1. Distinct between management of projects and operational activities.
2. Screen and select projects.
3. Assess the costs, people, time and quality associated with the projects.
4. Apply quantitative tools and techniques for risk management, budgeting and scheduling.
5. Knowledgeable about Government programs and policies w.r.t. entepreneurship
6. Know the parameters to assess opportunities and constraints for new business ideas
7. Discern the factors that can deem the idea successful and viable and write a business plan

Detailed Syllabi

Lecture-wise Breakup

Subject Code		**Semester**	**6**
Subject Name	**PROJECT MANAGEMENT AND ENTREPRENEURSHIP**		
Credits	**3**	**Contact Hours**	**3**

Course Outline

Module No.	**Subtitle of the Module**	**Topics**	**No. of Lectures**
1	**Introduction**	• The Definition of a "Project" • The Relationships Among Portfolios, Programs,	

		and Projects • Why Project Management? • The Project Life Cycle • Role of the Project Manager • Responsibilities and Competencies of the Project Manager	**4**
2	**Selection of project**	• Project Selection and Criteria of Choice • The Nature of Project Selection Models • Types of Project Selection Models • Risk analysis of the project	**4**
3	**Planning the project**	• Project Activity Planning • Initial Project Coordination and the Project Plan • Systems Integration • The Action Plan • The Work Breakdown Structure and Linear Responsibility Chart • Plan Scope Management: Define, Inputs., Tools and Techniques, Output	**5**
4	**Budgeting and financing the project**	• Estimating Project Budgets • Improving the Process of Cost Estimation • Plan Cost Management: Inputs, Tools and techniques, outputs, control process	**3**
5	**Scheduling (Gantt chart, PERT, CPM)**	• Plan Schedule Management : Inputs, Tools and Techniques, Outputs • Define Activities , Sequence Activities • Network Techniques: PERT and CPM • Hand-on experience on Microsoft Project Management software	**6**
6	**Resource allocation and monitoring**	• Resource Allocation • Crashing a Project	**3**

		• The Resource Allocation Problem • Resource Loading and Levelling • Goldratt's Critical Chain • Project procurement management	
7	**Project control and Project Termination**	• The Planning-Monitoring-Controlling Cycle • Information Needs and Reporting • Fundamental Purposes of Control • Three Types of Control Processes • The Design of Control Systems Control: A Primary Function of Management • Control of Change and Scope Creep • The Varieties of Project Termination • When to Terminate a Project • The Termination Process • The Final Report—A Project History • Detailed Project Report	**5**
8	**Introduction to Entrepreneurship**	• Role of the entrepreneur in India and around the globe. • Forces that are driving the growth of entrepreneurship • Benefits and drawbacks of entrepreneurship • Mistakes of entrepreneurship and how to avoid them • Entrepreneurial failure • Forms of Business Ownership	**2**
9	**Overview of Government Programs & Policies; Business and its functioning**	• Business and industry • Components of macro and micro business environment • Government Programs and Policies	**2**

10	**Business Idea and Feasibility**	• Creativity, innovation and entrepreneurship • Mental locks" that limit individual creativity • Steps in the creative process • Techniques for improving the creative process • Protection of intellectual property involving patents, trademarks, and copyrights.	**2**
11	**Building the business plan : marketing considerations**	• Marketing concept and evolution • Marketing process • Guerilla marketing	**2**
12	**Foundations of New Venture Finance**	• Understanding capital requirements • Identifying the sources of finance • Angel investing and venture finance • Managing cash flow	**2**
13	**Technical entrepreneur and The E-entrepreneur**	• Process of creating and growing high potential ventures • Basic approaches to launch an e-commerce effort • Basics of ERP	**2**
		Total No. of Lectures	**42**

Recommended Reading	
1.	Project Management – A Managerial Approach – Jack R. Meredith and Samuel J. Mantel, Jr. Seventh edition, Wiley Publications
2.	A Guide to the Project Management Body of Knowledge (PMBOK® Guide) – Fifth Edition published by Project Management Institute, Inc (USA).
3.	Entrepreneurship and New Venture Formation: Thomas W. Zimmerer, and Norman M. Scarborough. PHI
4.	Entrepreneurship: Strategies and Resources, 3/E -: Marc Dollinger; Prentice Hall
5.	Bringing New Technology to Market- Kathleen R. Allen, Prentice Hall
6.	Entrepreneurship in Action, 2/E - Mary Coulter; Prentice Hall

7.	Project Management – System Approach to Planning, Scheduling and Controlling – Harold Kerzner.
8.	Project Management – Harvey Maylor.
9.	Projects – Planning, Analysis, Financing, Implementation and Review – Prasanna Chandra.
10.	Practical Project Management – R.G. Ghattas and Sandra L. McKee
11.	Project Management – Garry R. Heerkens.
12.	http://www.projectminds.com/
13.	http://www.projectmanagement.com/
14.	http://www.projectsatwork.com/
15.	http://www.pmi.org/
16.	http://managementhelp.org/projectmanagement/
17.	office.microsoft.com/en-in/project/
18.	www.emeraldinsight.com/journal/ijmpb

Method of Evaluation

The lecture will focus the basic concepts, real problems and case-studies.	
Components	**Weightage**
T1	**15**
T2	**25**
T3	**35**
Internal assessment: • **Assignments** • **Case study** • **Presentation** • **Class assessment**	**25**

Python Programming Essentials

COURSE CODE: 18B11CI314

COURSE CREDITS: 3

CORE/ELECTIVE: CORE

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

1. Provide an understanding of the role computation can play in solving problems.
2. Help students, including those who do not plan to major in Computer Science and Electrical Engineering (like BI and BT), feel confident of their ability to write small programs that allow them to accomplish useful goals.
3. Position students so that they can compete for research projects and excel in subjects with programming components.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Familiarity about concepts of Python Programming. Broaden the knowledge about Variables, expressions and Functions in Python.	Familiarity
CO-2	Broaden the knowledge about Branching and Iteration. To have hands on skills on String Manipulation, Guess and Check, Approximations, Bisection	Assessment
CO-3	To learn about Decomposition Abstractions, Tuples, Lists, Dictionaries and Illustrative programs:	Assessment
CO-4	Files, Modules, Packages and Testing, Debugging, Exceptions, Assertions:	Usage
CO-5	Understanding and analyzing Object Oriented Programming:	Familiarity
CO-6	To have hands on skills on Illustrative programs(examples Sorting and Searching, Regular expressions) and GUI	Usage

Course Contents:

Unit	Contents	Lectures required
1	**Informal introduction to Python programming language:** What is a program?, What is debugging?, Formal and natural languages, Downloading and installing Python., The first program, Debugging **Variables, expressions and Functions in Python** Values and types, Variables, Variable names and keywords, Operators and operands, Expressions and statements, Interactive mode and script mode, Order of operations, String operations, Function calls, Type conversion functions, Math functions, Composition, Adding new functions, Definitions and uses, Flow of execution **Parameters and arguments**	5
2	**Branching and Iteration:** Loops, Multiple assignment, Updating variables, The while statement, Break **String Manipulation, Guess and Check, Approximations, Bisection:** String manipulation, Guess and check algorithms(e.g: find Square Root etc), Approximate solutions(e.g	8

	Successive approximation), Bisection method.	
3	**Decomposition, Abstractions:** divide and conquer (modules), Abstraction **Tuples, Lists, Dictionaries, Illustrative programs:** - Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters; - Tuples: tuple assignment, tuple as return value; - Dictionaries: operations and methods; advanced list processing – list comprehension; Illustrative programs: selection sort, insertion sort, mergesort, histogram	**7**
4	**Files, Modules, Packages**: Files and exception: text files, reading and writing files, format operator, Packages, Illustrative programs: word count, copy file. **Testing, Debugging, Exceptions, Assertions:** Unit testing framework(unit test), debugger for Python program(pdb), Handling an exception	**7**
5	**Object Oriented Programming:** -Classes, objects, attributes and methods; defining classes; design with classes, data modeling; persistent storage of objects -OOP, continued: inheritance, polymorphism, operator overloading, abstract classes.	**7**
6	**Illustrative programs(examples):** • Sorting and Searching • Regular expressions o Match function o Search function o Matching vs. Searching o Modifiers o Patterns **GUI :** Introduction, Tkinter programming, Tkinter widgets	**8**
Total lectures		**42**

Suggested Text Book(s):

1. Kenneth A. Lambert, The Fundamentals of Python: First Programs, 2011, Cengage Learning, ISBN: 978-1111822705

Suggested Reference Book(s):

1. Kenneth A. Lambert, The Fundamentals of Python: First Programs, 2011, Cengage Learning, ISBN: 978-1111822705.
2. Chun, Wesley. Core python programming. Vol. 1. Prentice Hall Professional, 2001.
3. Zelle, John M. Python programming: an introduction to computer science. Franklin, Beedle & Associates, Inc., 2004.
4. Gold, Steve. "Python: Python Programming Learn Python Programming In A Day-A Comprehensive Introduction To The Basics Of Python & Computer Programming." (2016).

Other useful resource(s):

1. https://onlinecourses.nptel.ac.in/noc18_cs35/preview
2. https://nptel.ac.in/courses/106106145/

3. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-0001-introduction-to-computer-science-and-programming-in-python-fall-2016/index.htm
4. https://docs.python.org/3/tutorial/index.html

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	*T-1	15	1 Hour.	Syllabus covered up to T-1
2	#T-2	25	1.5 Hours	Syllabus covered up to T-2
3.	$T-3	35	2 Hours	Entire Syllabus
4.	~Internal Assessment	25	Entire Semester	Assignment Quizzes Attendance

*In Test-I Paper the 20% of 15 Marks will be allocated to Introduction to Computers portion and 80% of 15 Marks will be allocated to Introduction to Programming portion.

#In Test-II Paper the 20% of 25 Marks will be allocated to syllabus of Test-I and 80% of 25 Marks will be allocated to further covered portion.

$In Test-III Paper the 40% of 30 Marks will be allocated to syllabus of Test-I+ Test-II and 60% of 30 Marks will be allocated to further covered portion.

~Internal Assessment will purely be focused on the assignments and quizzes based on Python Programming.

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Python Programming Essentials)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	2	3	1	2	3	3	2	1	1	1	3	**2.1**
CO-2	3	3	3	1	2	3	3	3	2	1	1	3	**2.3**
CO-3	3	3	3	1	2	3	2	3	2	1	1	3	**2.3**
CO-4	3	3	3	3	3	3	3	2	2	1	1	3	**2.5**
CO-5	3	3	3	2	2	3	3	3	2	1	1	3	**2.4**
CO-6	3	3	3	2	3	2	3	2	2	1	1	3	**2.3**
Average	**3**	**2.8**	**3**	**1.7**	**2.3**	**2.8**	**2.8**	**2.5**	**1.8**	**1**	**1**	**3**	

Approved in Academic Council held on 25.10.2018

Object-Oriented Systems and Programming

COURSE CODE: 18B11CI311

COURSE CREDITS: 3

CORE/ELECTIVE: CORE

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

1. To use object modelling technique to analyze problem requirements, design a solution to the problem and then implement the solution in Object-Oriented Programming Language(s) or database.
2. To strengthen their problem solving ability by applying the characteristics of an object-oriented approach.
3. To strengthen ability to design and represent solutions to problems using UML notations
4. To introduce object oriented concepts in C++ and Java.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	To learn the concepts of Objects, Classes, Methods, Constructors and Destructors	Usage
CO-2	To learn the designing of complex classes: Friend Functions and Static member functions, Inline functions, constant functions.	Usage
CO-3	To learn Inheritance: Single Inheritance, Multiple Inheritance, Multi-levelInheritance, Hierarchical Inheritance and Hybrid Inheritance.	Usage
CO-4	To learn the concept of Abstract classes and interfaces	Usage
CO-5	To learn the concepts of Operator overloading and conversion function	Usage
CO-6	To learn File Handling. Writing and reading data from the file, reading and writing the objects into the file.	Usage
CO-7	To learn the Exception Handling: try --catch and finally block, making user-defined exceptions.	Usage
CO-8	To learn the Unified Modeling Language (UML): Use Case Diagrams, State Diagrams, Sequence Diagrams, Communication Diagrams, and Activity Diagrams.	Familiarity

Course Contents:

Unit	Contents	Lectures required
1	Structured versus Object-Oriented programming, Object-Oriented paradigm. Defining Objects, Classes, Data members, Member functions, Constructors and Destructors in C++. Inline Functions, Friend Functions, Constant member functions, and Static members (static data and static member functions). Function overloading, Operator overloading and Conversion functions. Using the concepts of File handling	**12**
2	Polymorphism and Inheritance in C++. Abstract classes, virtual function, pure virtual functions, and virtual base classes in C++.	**6**
3	Function templates and Class templates	**3**
4	Introduction to Java and its features. Defining Classes in Java, Wrapper classes, Packages and Exception handling in Java	**7**
5	Inheritance and Interfaces in Java. Abstract class, abstract methods,	**5**

	final class and final method in Java	
6	Basic principles of Software engineering. System analysis, design, testing and debugging. Unified Modeling Language (Class Diagram, Use Case Diagram, State Diagram, Sequenced Diagram, Communication Diagram, Activity Diagram)	**9**
Total lectures		**42**

Suggested Text Book(s):

1. Lafore R., Object oriented programming in C++, Waite Group
2. Java 2: The Complete Reference, Fifth Edition -- by Herbert Schildt
3. Satzinger, Jackson, Burd, Object-Oriented Analysis & Design

Suggested Reference Book(s):

1. Stroustrap B., The C++ Programming Language, Addison Wesley
2. Bruce Eckel, Thinking in C++
3. Bruce Eckel, Thinking in Java

Other useful resource(s):

1. Link to NPTEL course contents:

    a. https://onlinecourses.nptel.ac.in/noc16_cs17/preview
    b. http://www.nptelvideos.com/java/java_video_lectures_tutorials.php
    c. https://onlinecourses.nptel.ac.in/noc17_cs25/announcements

2. Link to topics related to course:

    a. https://www.tutorialspoint.com/cplusplus/
    b. http://www.cplusplus.com/doc/tutorial

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Internal Assessment	25	Entire Semester	Assignment Quizzes Attendance

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Object-Oriented Systems and Programming)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	3	3	2	2	3	3	2	3	3	3	**2.8**

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CO-2	3	3	3	2	1	1	2	3	2	3	3	3	**2.4**
CO-3	3	3	2	2	2	1	2	2	2	3	3	3	**2.3**
CO-4	3	3	3	2	2	1	2	3	2	3	3	3	**2.5**
CO-5	3	3	3	3	2	1	2	3	2	1	3	3	**2.4**
CO-6	3	3	3	3	2	3	2	3	2	2	3	3	**2.7**
CO-7	3	3	2	2	2	3	3	2	2	3	3	3	**2.6**
CO-8	3	3	3	3	3	2	3	3	2	1	3	1	**2.5**
Average	**3**	**3**	**2.8**	**2.5**	**2**	**1.8**	**2.4**	**2.8**	**2**	**2.4**	**3**	**2.8**	

Approved in Academic Council held on 25.10.2018

Database Management Systems

COURSE CODE: 18B11CI313

COURSE CREDITS: 3

CORE/ELECTIVE: CORE

: 3-0-0

Pre-requisite: Introduction to Computer Programming, Discrete Mathematics, Data Structures

Course Objectives:

1. To study the physical and logical database designs, database modeling, relational, hierarchical, and network models
2. To understand and use data manipulation language to query, update, and manage a database.
3. To develop an understanding of essential DBMS concepts such as: database security, integrity, concurrency, distributed database, and intelligent database, Client/Server (Database Server), Data Warehousing.
4. To design and build a simple database system and demonstrate competence with the fundamental tasks involved with modeling, designing, and implementing a DBMS.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Explain the characteristics, architecture of database approach, its components, different data models and the examples of their usage.	Familiarity
CO-2	For a given query write relational algebra expressions for that query and optimize the developed expressions.	Usage
CO-3	For a given specification of the requirement, design the databases using E-R method and normalization.	Usage
CO-4	Determine the functional dependency between two or more attributes, compute the closure of a set of attributes, evaluate a proposed decomposition	Assessment
CO-5	Give examples of the application of primary, secondary, and clustering indexes, explain the theory and application of internal and external hashing techniques.	Assessment
CO-6	Implement the isolation property, including locking, time stamping based on concurrency control and Serializability of scheduling.	Assessment
CO-7	Familiarize with the security in databases and gaining familiarity with other popular databases used in the industry	Familiarity

Course Contents:

Unit	Contents	Lectures required
1	**Database system architecture:** Data Abstraction, Data Independence, Data Definition Language (DDL), Data Manipulation Language (DML). **Data models:** Entity-relationship model, network model, relational and object oriented data models, integrity constraints, data manipulation operations.	5
2	**Relational query languages:** Relational algebra, Tuple and domain relational calculus, SQL3, DDL and DML constructs, Open source and Commercial DBMS -	15

	MYSQL, ORACLE, DB2, SQL server. **Relational database design:** Domain and data dependency, Armstrong's axioms, Normal forms, Dependency preservation, Lossless design. **Query processing and optimization:** Evaluation of relational algebra expressions, Query equivalence, Join strategies, Query optimization algorithms.	
3	**Storage strategies:** Indices, B-trees, hashing.	**6**
4	**Transaction processing:** Concurrency control, ACID property, Serializability of scheduling, Locking and timestamp based schedulers, Multi-version and optimistic Concurrency Control schemes, Database recovery.	**9**
5	**Database Security:** Authentication, Authorization and access control, DAC, MAC and RBAC models, Intrusion detection, SQL injection.	**5**
6	**Advanced topics:** Object oriented and object relational databases, Logical databases, Web databases, Distributed databases, Data warehousing and data mining.	**3**
Total lectures		**42**

Suggested Text Book(s):

1. "Fundamentals of Database Systems" Elmasri, Navathe, Pearson Education.
2. "Database system concepts" Henry F Korth, Abraham Silberschatz, S. Sudurshan, McGraw-Hill Ellis

Suggested Reference Book(s):

1. "Database Systems: A Practical Approach to design, Implementation and Management". Thomas Connolly, Carolyn Begg; Third Edition, Pearson Education.
2. Bipin C Desai, ?An Introduction to Database Systems?, Galgotia. Publications Pvt Limited, 2001
3. "An Introduction to Database Systems", C.J.Date, Pearson Education.
4. "A first course in Database Systems", Jeffrey D. Ullman, Jennifer Windon, Pearson, Education.
5. "Data Management: databases and organization", Richard T. Watson, Wiley.
6. " Data Modeling Essentials", Graeme C. Simxion, Dreamtech.

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Other useful resource(s):

1. Link to NPTEL course contents:
   https://www.youtube.com/watch?v=EUzsy3W4I0g&list=PL9426FE14B809CC41
2. Link to topics related to course:
   a. https://www.tutorialspoint.com/dbms/database_normalization.htm
   b. https://www.igi-global.com/journal/journal-database-management/1072
   c. https://www.tutorialspoint.com/dbms/dbms_hashing.htm

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1

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2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Internal Assessment	25	Entire Semester	Assignment Quizzes Attendance

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Database Management Systems)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	2	1	2	2	2	1	2	3	3	2	**2.2**
CO-2	3	3	3	2	2	2	3	2	2	1	2	2	**2.3**
CO-3	3	3	2	1	1	3	3	3	3	3	1	1	**2.3**
CO-4	3	2	3	1	2	2	2	2	1	2	1	2	**1.9**
CO-5	3	2	2	1	2	3	3	2	1	3	2	1	**2.1**
CO-6	3	2	3	1	1	3	2	1	1	3	2	1	**1.9**
CO-7	3	3	2	1	1	3	3	1	3	3	3	1	**2.3**
Average	**3**	**2.6**	**2.4**	**1.1**	**1.6**	**2.6**	**2.6**	**1.7**	**1.9**	**2.6**	**2**	**1.4**	

Python Programming Lab

COURSE CODE: 18B17CI374

COURSE CREDITS: 2

CORE/ELECTIVE: CORE

L-T-P: 0-0-4

Pre-requisite: None

Course Objectives:

1. Learn syntax, semantics and create Functions in Python.
2. Understand the usage of Lists, Dictionaries, and arrays in Python.
3. Learn the Implementation of object oriented programming concepts in Python
4. Learn different data structure in Python.
5. Understand file handling in Python
6. Implement GUI applications and browser.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO1	Familiarity about concepts of Python Programming. Broaden the knowledge about Variables, expressions and Functions in Python.	Familiarity
CO2	Broaden the knowledge about Branching and Iteration. To have hands on skills on String Manipulation, Guess and Check, Approximations, Bisection	Assessment
CO3	To learn about Decomposition Abstractions, Tuples, Lists, Dictionaries and Illustrative programs:	Assessment
CO4	Files, Modules, Packages and Testing, Debugging, Exceptions, Assertions:	Usage
CO5	Understanding and analyzing Object Oriented Programming:	Familiarity
CO6	To have hands on skills on Illustrative programs(examples Sorting and Searching, Regular expressions) and GUI	Usage

List of Experiments

S.No.	Description	Hours
1	1. Write a Python program to get the Python version you are using. 2. Write a Python program which accepts the radius of a circle from the user and compute the area.	**2**
2	1. Write a Python program to display the current date and time. 2. Write a Python program which accepts the radius of a circle from the user and compute the area.	2
3	1. Write a Python program which accepts the user's first and last name and print them in reverse order with a space between them. 2. Write a Python program to display the first and last colors from the following list. color_list = ["Red","Green","White" ,"Black"].	2
4	1. Write a Python program to print the documents (syntax, description etc.) of Python built-in function(s). Samplefunction :abs() ExpectedResult : abs(number)->number Return the absolute value of the argument.	2
5	Write a Python program to get the difference between a given number and 17, if the	2

	number is greater than 17 return double the absolute difference. Write a Python program to test whether a number is within 100 of 1000 or 2000. Write a Python program to check whether a specified value is contained in a group of values. Test Data : 3 -> [1, 5, 8, 3] : True -1 -> [1, 5, 8, 3] : False	
6	Write a Python program to print all even numbers from a given numbers list in the same order and stop the printing if any numbers that come after 237 in the sequence. Sample numbers list : numbers = [386, 462, 47, 418, 907, 344, 236, 375, 823, 566, 597, 978, 328, 615, 953, 345, 399, 162, 758, 219, 918, 237, 412, 566, 826, 248, 866, 950, 626, 949, 687, 217, 815, 67, 104, 58, 512, 24, 892, 894, 767, 553, 81, 379, 843, 831, 445, 742, 717, 958,743, 527] Now do it using file as input.	**2**
7	Write a Python program that accepts a single integer value entered by the user. If the value entered is less than one, the program prints nothing. If the user enters a positive integer, n, the program prints an n×n box drawn with * characters. If the users enters 1, for example, the program prints * If the user enters a 2, it prints ** ** An entry of three yields.	**2**
8	Write a Python program to sum of two given integers. However, if the sum is between 15 to 20 it will return 20. Write a Python program to compute the future value of a specified principal amount, rate of interest, and a number of years. Test Data : amt = 10000, int = 3.5, years = 7 Expected Output : 12722.79	**2**
9	Write a Python program to create an array of 5 integers and display the array items. Access individual element through indexes. Write a Python program to convert an array to an ordinary list with the same items.	**2**
10	Write a Python program to display all the member name of an enum class ordered by their values. Expected Output: Country Name ordered by Country Code: Afghanistan Algeria Angola Albania Andorra Antarctica	**2**
11	Write a Python program to get all values from an enum class. Expected output: [93, 355, 213, 376, 244, 672].	**2**
12	Write a Python program to get an array buffer information Expected Output: Array buffer start address in memory and number of elements. (25855056, 2)	**2**
13,14	Write a Python program to push three items into a heap and return the smallest item from the heap. Also Pop and return the smallest item from the heap ExpectedOutput: Items in the heap: ('V', 1) ('V', 3) ('V', 2) ---------- The smallest item in the heap: ('V', 1) ---------- Pop the smallest item in the heap: ('V', 2) ('V', 3)	**4**
15,16	Write a function named print_big_enough that accepts two parameters, a list of numbers and a number. The function should print, in order, all the elements in the list that are at least as large as the second parameter.	**4**
17,18	Write a function called draw_rectangle that takes a Canvas and a Rectangle as	**4**

	arguments and draws a representation of the Rectangle on the Canvas. 2. Add an attribute named color to your Rectangle objects and modify draw_rectangle so that it uses the color attribute as the fill color. 3. Write a function called draw_point that takes a Canvas and a Point as arguments and draws a representation of the Point on the Canvas. 4. Define a new class called Circle with appropriate attributes and instantiate a few Circle objects. Write a function called draw_circle that draws circles on the canvas. 5. Write a program that draws the national flag of the India. Hint: you can draw a polygon like this: points = [[-150,-100], [150, 100], [150, -100]] canvas.polygon(points, fill='saffron,white,green')	
19,20	The datetime module provides date and time objects that are similar to the Date and Time objects in this chapter, but they provide a rich set of methods and operators. Read the documentation at http: // docs. python. org/ 2/ library/ datetime. html . 1. Use the datetime module to write a	**4**
	program that gets the current date and prints the day of the week. 2. Write a program that takes a birthday as input and prints the user‟s age and the number of days, hours, minutes and seconds until their next birthday. 3. For two people born on different days, there is a day when one is twice as old as the other. That‟s their Double Day. Write a program that takes two birthdays and computes their Double Day. 4. For a little more challenge, write the more general version that computes the day when one person is n times older than the other.	
21,22	This exercise is a cautionary tale about one of the most common, and difficult to find, errors in Python. Write a definition for a class named Kangaroo with the following methods: 1. An_init_ method that initializes an attribute named pouch_contents to an empty list. 2. A method named put_in_pouch that takes an object of any type and adds it to pouch_contents. 3. A_str method that returns a string representation of the Kangaroo object and the contents of the pouch. Test your code by creating two Kangaroo objects, assigning them to variables named kanga and roo, and then adding roo to the contents of kanga‟s pouch.	**4**
23,24	You will write code that makes Turtles play tag. If you are not familiar with the rules of tag, see http: // en. wikipedia. org/ wiki/ Tag_ (game) . 1. Download http: // thinkpython. com/ code/ Wobbler. py and run it. You should see a TurtleWorld with three Turtles. If you press the Run button, the Turtles wander at random. 2. Read the code and make sure you understand how it works. The Wobbler class inherits from Turtle, which means that the Turtle methods lt, rt, fd and bk work on Wobblers. The step method gets invoked by TurtleWorld. It invokes steer, which turns the Turtle in the desired direction, wobble, which makes a random turn in proportion to the Turtle‟s clumsiness, and move, which moves forward a few pixels, depending on the Turtle‟s speed. 3. Create a file named Tagger.py. Import everything from Wobbler, then define a class named Tagger that inherits from Wobbler. Call make_world passing the Tagger class object as an argument. 4. Add a steer method to Tagger to override the one in Wobbler. As a starting place, write a version that always points the Turtle toward the origin. Hint: use the math function atan2 and the Turtle attributes x, y and heading. 5. Modify steer so that the Turtles stay in bounds. For debugging, you might want to use the Step button, which invokes step once on each Turtle. 6. Modify steer so that each Turtle points toward its nearest neighbor. [Hint: Turtles have an attribute, world, that is a reference to the TurtleWorld they live in, and the TurtleWorld has an attribute, animals, that is a list of all Turtles in the world. 7. Modify steer so the Turtles play tag. You can add methods to Tagger and you can override steer and_ init_ , but you may not modify or override step, wobble or move. Also, steer is allowed to change the heading of the Turtle but not the position. Adjust the rules and your steer method for good quality play; for example, it	**4**

	should be possible for the slow Turtle to tag the faster Turtles eventually.]	
25,26	A vector graphics editor is a program that allows users to draw and edit shapes on the screen and generate output files in vector graphics formats like Postscript and SVG. Write a simple vector graphics editor using Tkinter. At a minimum, it should allow users to draw lines, circles and rectangles, and it should use Canvas.dump to generate a Postscript description of the contents of the Canvas. As a challenge, you could allow users to select and resize items on the Canvas	**4**
27,28	Use Tkinter to write a basic web browser. It should have a Text widget where the user can enter a URL and a Canvas to display the contents of the page. You can use the urllib module to download files (see Exercise 14.6) and the HTMLParser module to parse the HTML tags (see http: // docs. python. org/ 2/ library/ htmlparser. html). At a minimum your browser should handle plain text and hyperlinks. As a challenge you could handle background colors, text formatting tags and images.	**4**
Total Lab hours		**56**

Minor Project(s) – (Only for 2 credit lab)

1. Create a Python project of a Magic 8 Ball which is a toy used for fortune-telling or seeking advice.
    a. Allow the user to input their question.
    b. Show an in progress message.
    c. Create 10/20 responses, and show a random response.
    d. Allow the user to ask another question/advice or quit the game.
2. The “rank” of a word is its position in a list of words sorted by frequency: the most common word has rank 1, the second most common has rank 2, etc. Zipf‟s law describes a relationship between the ranks and frequencies of words in natural languages (http: // en. wikipedia. org/ wiki/ Zipf's_ law). Specifically, it predicts that the frequency, f , of the word with rank r is: f = cr−s where s and c are parameters that depend on the language and the text. If you take the logarithm of both sides of this equation, you get: log f = log c − slog r. So if you plot log f versus log r, you should get a straight line with slope −s and intercept log c. Write a program that reads a text from a file, counts word frequencies, and prints one line for each word, in descending order of frequency, with log f and log r. Use the graphing program of your choice to plot the results and check whether they form a straight line. Can you estimate the value of s?

Suggested Books/Resources:

1. Learning with Python: How to Think Like a Computer Scientist Paperback – Allen Downey , Jeffrey Elkner, 2015
2. Exploring Python, Timothy A. Budd, Mc Graw Hill Education
3. Introduction to Python for Computational Science and Engineering (A beginner's guide), Hans Fangohr
4. Learning Python, Fourth Edition, Mark Lutz, O‟Reilly publication
5. How to Make Mistakes in Python Author: Mike Pirnat
6. Head First Python Paperback – by Paul Barry
7. Link to topics related to course:
    a. Think Python How to Think Like a Computer Scientist
    b. https://greenteapress.com/wp/think-python/
    c. https://www.w3schools.com/python/
    d. https://www.python.org/

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Attendance	15 Marks
4	Lab Assessment	45 Marks
	Total	100 marks

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Average
CO1	3	2	3	1	2	3	3	2	1	1	1	3	**2.1**
CO2	3	3	3	1	2	3	3	3	2	1	1	3	**2.3**
CO3	3	3	3	1	2	3	2	3	2	1	1	3	**2.3**
CO4	3	3	3	3	3	3	3	2	2	1	1	3	**2.5**
CO5	3	3	3	2	2	3	3	3	2	1	1	3	**2.4**
C06	3	3	3	2	3	2	3	2	2	1	1	3	**2.3**
Average	**3**	**2.8**	**3**	**1.7**	**2.3**	**2.8**	**2.8**	**2.5**	**1.8**	**1**	**1**	**3**	

Approved in Academic Council held on 25.10.2018

Object-Oriented Systems and Programming Lab

COURSE CODE: 18B17CI371

COURSE CREDITS: 2

CORE/ELECTIVE: CORE

: 0-0-4

Pre-requisite: None

Course Objectives:

1. To use object modelling technique to analyze problem requirements, design a solution to the problem and then implement the solution in Object-Oriented Programming Language(s) or database.
2. To strengthen their problem solving ability by applying the characteristics of an object-oriented approach.
3. To strengthen ability to design and represent solutions to problems using UML notations.
4. To introduce object-oriented concepts in C++ and Java.

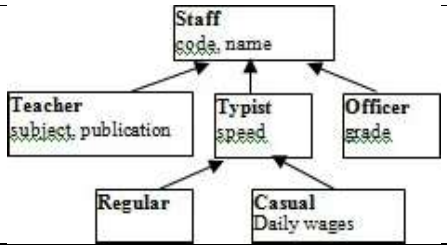
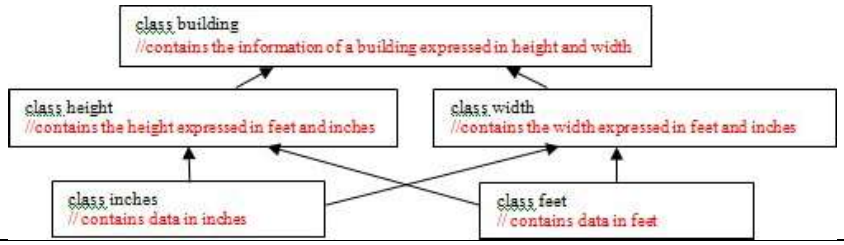
Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO1	To learn the concepts of Objects, Classes, Methods, Constructors and Destructors	Usage
CO2	To learn the designing of complex classes: Friend Functions and Static member functions, Inline functions, constant functions.	Usage
CO3	To learn Inheritance: Single Inheritance, Multiple Inheritance, Multi-level Inheritance, Hierarchical Inheritance and Hybrid Inheritance.	Usage
CO4	To learn the concept of Abstract classes and interfaces	Usage
CO5	To learn the concepts of Operator overloading and conversion function	Usage
CO6	To learn File Handling. Writing and reading data from the file, reading and writing the objects into the file.	Usage
CO7	To learn the Exception Handling: try --catch and finally block, making user-defined exceptions.	Usage
CO8	To learn the Unified Modeling Language (UML): Use Case Diagrams, State Diagrams, Sequence Diagrams, Communication Diagrams, and Activity Diagrams.	Familiarity

List of Experiments

S.No	Description	Hours
1	Create a class called Complex in C++ for performing arithmetic with complex numbers. Use double variables to represent the private data of the class. Provide public member functions for each of the following: *(Define all the member functions outside the class)* a) Enter the values of real and imaginary part. b) Addition of two Complex numbers: (The real parts are added together and the imaginary parts are added together. c) Subtraction of two Complex numbers. (The real part of the right operand is subtracted from the real part of the left operand and the imaginary part of the right operand is subtracted from the imaginary part of the left operand. ***d)*** Printing Complex numbers in the form: **a + b *i***	**2**
2	Define a class in C++ to represent a bank account. Include the following members:	**2**

	Data members: a) Name of the depositor b) Account number c) Type of account d) Balance amount in the account ***Member functions:*** *(Define all the member functions inside the class)* a) To assign initial values b) To deposit an amount c) To withdraw an amount after checking the balance d) To display name and balance Write a main function to create a database of 10 customers	
3	a) Employees have a number, date of birth (dd-mm-yyyy), rank, and salary. When an employee is first recruited then all these are given values of 0. Upon confirmation, the actual values of these are entered for the employee. Their rank can be incremented by 1 and when this happens an employee gets an increment of 25%. Write a C++ class for Employee. b) Students are registered in a University. When students are created then they are given default values (zeroes or blanks) for roll_number, department, year, and semester of study. At registration time, the values of these attributes of student are updated with the proper values. Students can be promoted and their departments can be changed. Write a C++ class for Student.	**2**
4	Users of the computer have profile which consists of Name, Password, and Access Rights. Access rights take on values X, R, W, and ALL. It is possible to have default values for Password and Access rights which are the first three letters of the Name and ALL respectively. Users can change their password and access rights. Write a class User in C++ and create a user named Rajesh.	**2**
5	Define two classes Distance1 and Distance2 in C++. Distance1 stores distance in miles and Distance2 in kmeters & meters. Write a program that reads values of the class objects and adds one object of Distance1 with the object of Distance2 class. The display should be in the format of miles or kmeters & meters depending on the type of object (Distance1 or Distance2) being used to invoke the function. (Hint: Make use of friend function).	**2**
6	Implement a singleton class in C++. A class whose number of instances that can be instantiated is limited to one is called a singleton class. (Hint: make use of static members).	**2**
7	Imagine a publishing company that markets both books and audio- cassette version of its works. Create a class Publication in C++ that stores the title (a string) and price (type float) of a publication. From this class derive two classes: Book, which adds a page count and Tape, which adds playing time in minutes. These classes should have getdata() function to get its data from the user and the putdata() function to display its data. Write a main() program to test the book and tape classes by creating instances of them, asking the user to fill in their data with getdata() and displaying the data with putdata().	**2**
8	Implement the class hierarchy as shown in the following figure (using C++).	**2**

		
19	The database created in the experiment 8 does not include educational information of the staff. It has been decided to add this information to teacher and officers (not for typists) which will help the management in decision making with regard to training, promotion, etc. Add another data class called Education that holds two pieces of education information, namely, highest qualification in general education and highest professional qualification. The class should be inherited by the class Teacher and Officer. Modify the program of above exercise to incorporate these additions. Include overloaded constructors in all above classes.	**2**
10	Implement the class hierarchy shown in the following figure, using C++. Define appropriate member functions (including constructors and destructors) to convert feet class object into inches class object and vice versa. Also the objects of the feet and inches constructors should construct their objects using the constructors of the height and width constructor which in turn call building constructor.	**2**
		
11	Define a class Directory with members: name and phone number. Use the class object to store each set of data into a text file "phone.txt". The names contain only one word and the names and telephone numbers are separated by white spaces. Write a C++ program to read the file and output the list in two columns, such as: John 23456 Ahmed 9876	**2**
12	Write an interactive, menu-driven program that will access the file created in the experiment 11 and implement the following tasks: Determine the telephone number of the specified person. b) Determine the name if a telephone number is known. Update the telephone number, whenever there is a change	**2**
13	Define a class Queue in C++ that contains elements of type integer. Define two operators on Queue, „+" to insert an element in it and „–„ to remove and element from it. Use the friend function approach first and then the one without friends	**2**
14	A programmer wants to manipulate arrays. Two arrays are equal if (a) they have the same dimension, (b) are of the same size, and (c) contain identical values in their corresponding elements. Comparison is done using the operator „= =" which returns true or false. Also, arrays can be copied to one another using the operator „=". Implement the foregoing using the friend function approach first and then the one without friends. Which one is preferable and why?	**2**
15	An istream class overloads the >> operator for the standard types [int, long, double, float, char]. For example, the statement cin >> x ; calls the appropriate >> operator function for the istream class defined in iostream.h and uses it to direct this input	**2**

	stream into the memory location represented by the variable x. Similarly, the ostream class overloads the << operator, which allows the statement cout << x to send the value of x to ostream cout for output. Overload these operators to enter the object‟s data members through input operator >> and display the values of these members by using the output operator <<.	
16	Define a class Distance in C++ with data members: kmeter and meter. Define conversion function to convert Distance object into distance in miles (float type). Also make use of constructor to convert distance in miles (float type) into object of Distance class.	**2**
17	Define two classes Polar and Rectangle (using C++) to represent points in polar and rectangle systems. Use the conversion routines to convert from one system to the other.	**2**
18	Define a function template in C++ to sort an array of elements of int type, string type, float type and user-defined type Distance with data members: kmeter & meter.	**2**
19	Define a template class LinkedList in C++ with the following member functions: createList(), displayList(), insertElement(), and deleteElement(); In the main() function invoke above functions for the list of integer numbers, floating numbers and complex numbers.	**2**
20	Define a class Employee in Java with members: name, age and salary and methods: enterData() to enter the record of the employee through keyboard: displayData() to display the details of the employee. Define two user defined exceptions that are thrown when) The name entered has numeric character(s).) The age of the person is less than 18 or greater than 60.	**2**
21	Write a program in Java that demonstrates handling of exceptions in inheritance tree. For example, create a base class called “Father” and derived class called “Son” which extends the base class. In Father class, implement a constructor which takes the age and throws the exception WrongAge() where the input age <0. In Son class, implement a constructor that uses both father and son‟s age and throws an exception if son‟s age is >= father‟s age.	**2**
22	Define a class Person in the package MyPackage. The class has data members as: name, age, address and Methods to enter the data through keyboard and display them. Make use of overloaded constructors in the class. Now, import the above class and inherit the class Employee from this. The sub-class should have overloaded functions and also call to the base class constructors. In the main class, define a database of 5 objects and display them.	**2**
23	Define an abstract class Shape in Java, with two abstract functions: enterData() and displayArea(). Define two classes Circle and Rectangle inside a new file that inherit the class Shape and implement the abstract functions in their own way. Illustrate the concept of dynamic binding in this program.	**2**
24	Find the source code for the Vector class in the Java source code library that comes with all Java distributions. Copy this code and make a special version called intVector that holds only integers. Consider what it would take to make a special version of Vector for all the primitive types. Now consider what happens if you want to make a linked list class that works with all the primitive types. If parameterized types are ever implemented in Java, they will provide a way to do this work for you automatically.	**2**

25	Create a class MyString in Java containing a String object so that you initialize in the constructor using the constructor‟s argument. Add a toString() method and a method concatenate() that appends a String object to your internal string. Implement clone() in MyString. Create two static methods that each take a myString x handle as an argument and call x.concatenate(“test”), but in the second method call clone() first. Test the two methods and show the difference effects.	
26	**Design the USE-CASE diagram for the following:** A description of the behavior of an automated telling machine (ATM) is given below: A user begins a transaction at the ATM by entering a bank card. If the card is readable by the machine the user is prompted to enter their personal identification number (PIN). Once this number has been entered, a menu is presented to the user containing the following options: show account balance, withdrawal with receipt and withdrawal without receipt. If the user selects one of the withdrawal options, they are prompted to enter an amount of money to withdraw; the amount entered must be a multiple of 10. The user‟s PIN is validated when the ATM sends the details of the transaction to the bank‟s remote computer. If the PIN is invalid, the user is given the option of re-entering it and the selected transaction is retired. This is repeated if the new PIN is also invalid. Once three invalid PINs have been entered, the transaction processing depends on the transaction type selected. For a show balance transaction, the balance is displayed on the screen and after they have confirmed this, the user is returned to the transaction menu. A withdrawal transaction may fail if the user has executed the amount of money that can be withdrawn from the account; in this case an error message is displayed and, after confirmation, the user is returned to the transaction menu. Otherwise, the user‟s card is returned and the money is issued, followed by the receipt if required. At any point where user input, other than a simple confirmation, is required, a cancel option is provided. If this is selected, the user‟s card is returned and their interaction with the ATM terminates.	**2**
27	**Design the Collaboration and Sequence diagram for the following:** Many word processors, graphical editors and similar tools provide cut, copy and paste operations by means of some kind of a clipboard facility. At run-time suppose that such a system consists of an instance of an Editor class linked to a number of instances of a Element class. Elements are the items manipulated by a tool, such as words or shapes. Some of the elements may have been selected by the user. The editor is also linked to an instance of a Clipboard class, which in turn maintains links to all the elements that have been placed in the clipboard. An element cannot simultaneously be displayed by the editor and on the clipboard. Draw a collaboration showing a configuration where there are several elements displayed by the editor and one element on the clipboard. Assume that the selected elements are identified by an additional link	**2**
	from the editor. Draw a sequence diagram showing what happens when the editor receives a cut message from a client. The effect of this is that all the currently selected elements are moved to the clipboard.	

	Draw a sequence diagram showing what happens when the editor receives a paste message from a client. The effect of this is that all the elements on the clipboard are moved back to the editor. Draw a sequence diagram showing what happens when the editor receives a copy message from a client. The effect of this is that all the currently selected elements are copied to the clipboard. Assume that elements implement a clone operation, which returns a exact copy of the element. Draw equivalent collaboration diagrams for each of your answers.	
28	**Draw a state diagram expressing these facts about the display of windows.** A window in a window management system on a computer can be displayed in one of the three states: maximized, where it takes up the entire screen; normal, where it is displayed as a small icon. When a window is opened, it will be displayed as a normal window, unless minimize on use has been selected, in which case it will be displayed as an icon. A normal window and an icon can be maximized; a maximized window and a normal window can be minimized or reduced to an icon. Maximized windows can be restored to their normal size and icons can be restored to the size they had before they were minimized. Icons and normal windows can be moved as normal windows can also be resized. No matter how it is displayed, a window can always be closed.	**2**
Total Lab hours		**56**

Suggested Books/Resources:

1. Lafore R., Object oriented programming in C++, Waite Group
2. Java 2: The Complete Reference, Fifth Edition -- by Herbert Schildt
3. Satzinger, Jackson, Burd, Object-Oriented Analysis & Design
4. Stroustrap B., The C++ Programming Language, Addison Wesley
5. Bruce Eckel, Thinking in C++
6. Bruce Eckel, Thinking in Java

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Attendance	15 Marks
4	Lab Assessment	45 Marks
	Total	100 marks

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Average
CO1	3	3	3	3	2	2	3	3	2	3	3	3	**2.8**
CO2	3	3	3	2	1	1	2	3	2	3	3	3	**2.4**
CO3	3	3	2	2	2	1	2	2	2	3	3	3	**2.3**
CO4	3	3	3	2	2	1	2	3	2	3	3	3	**2.5**
CO5	3	3	3	3	2	1	2	3	2	1	3	3	**2.4**
C06	3	3	3	3	2	1	2	3	2	2	3	3	**2.5**
CO7	3	3	2	2	2	3	3	2	2	3	3	3	**2.6**
CO8	3	3	3	3	3	2	3	3	2	1	3	1	**2.5**
Average	**3**	**3**	**2.8**	**2.5**	**2**	**1.5**	**2.4**	**2.8**	**2**	**2.4**	**3**	**2.8**	

Database Management Systems Lab

COURSE CODE: 18B17CI373

COURSE CREDITS: 2

CORE/ELECTIVE: CORE

: 0-0-4

Pre-requisite: None

Course Objectives:

1. Develop the ability to design, implement and manipulate databases.
2. Introduce students to build database management systems.
3. Apply DBMS concepts to various examples and real life applications.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO1	Design and implement a database schema	Usage
CO2	Design different views of tables for different users and to apply embedded and nested queries	Usage
CO3	Understand the use of structured query language and its syntax , transactions, database recovery and techniques for query optimization	Familiarity
CO4	Understand , analyze and apply common SQL statements including DDL , DML , DCL statements to perform different operations	Assessment & Usage
CO5	Develop application programs using PL/SQL	Usage
CO6	Design and implement a project using embedded SQL and GUI	Usage

List of Experiments

S.No	Description	Hours
1	To implement Data Definition language commands Create database/table, alter, drop, truncate	**2**
2	To implement Constraints as a part of Data Definition language Primary key, Foreign Key, Check, Unique	**2**
3	To implement Constraints as a part of Data Definition language Null, Not null, Default, Enable Constraints, Disable Constraints, Drop Constraints	**2**
4	To implement Data Manipulation Language Commands Insert, Select, Update, Delete	**2**
5	To implement Data Control Language, Transfer Control Language Commands commit, rollback, save point, grant, revoke	**2**
6	To practice in Built Functions Date functions, numerical functions, character functions, conversion functions, group functions, count functions etc.	**2**
7	To practice group by, having clause and special operators such as between, like, in etc.	**2**
8	To practice Nested Queries	**2**
9	To practice Nested Queries and Join Queries Inner join, Left join, Right join, Full join	**2**
10	To implement Set Operators Union, Intersect, Minus	**2**
11	To implement Views	**2**
12	To implement and practice PL/SQL control structure If, if then else, else if, nested if	**2**
13	To implement and practice PL/SQL control structure For loop, while loop	**2**

14	To implement and practice PL/SQL procedures	**2**
15	To implement and practice PL/SQL functions	**2**
16	To implement triggers	**2**
17	To study about various Visual Basic (front end) tools	**2**
18	To design and implement forms using visual basic	**2**
19	To design and implement a menu design using Visual Basic	**2**
20	To implement report generation using VB.	**4**
21	To create a database for payroll processing system using SQL	**4**
22	Implement the above created database using VB.	**4**
23,24,25	**Minor Projects – (Only for 2 credit lab)** Banking System University System Company System Hospital Management System Passport Automation System	**6**
Total Lab hours		**56**

Suggested Books/Resources:

1. "Fundamentals of Database Systems" Elmasri, Navathe, Pearson Education.
2. “Database system concepts” Henry F Korth, Abraham Silberschatz, S. Sudurshan, McGraw-Hill
3. “Database Systems: A Practical Approach to design, Implementation and Management”. Thomas Connolly, Carolyn Begg; Third Edition, Pearson Education.
4. Bipin C Desai, ?An Introduction to Database Systems?, Galgotia. Publications Pvt Limited, 2001
5. “An Introduction to Database Systems”, C.J.Date, Pearson Education.
6. “A first course in Database Systems”, Jeffrey D. Ullman, Jennifer Windon, Pearson, Education.
7. Orcacle manual
8. Link to topics related to course:
   a. https://www.youtube.com/watch?v=EUzsy3W4I0g&list=PL9426FE14B809CC41
   b. https://www.w3schools.com/sql/
   c. https://www.codementor.io/collections/learn-sql-bwclmlodl

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Attendance	15 Marks
4	Lab Assessment	45 Marks
	Total	100 marks

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Average
CO1	3	3	2	2	2	2	2	1	2	3	3	1	**2.2**
CO2	3	1	3	2	2	2	3	2	2	3	2	2	**2.3**
CO3	3	3	2	1	1	3	3	3	3	3	1	1	**2.3**
CO4	3	2	2	2	2	2	2	2	1	2	1	1	**1.8**
CO5	3	3	2	1	2	3	3	2	1	2	2	1	**2.1**
C06	3	3	2	1	1	3	3	1	3	3	3	1	**2.3**
Average	**3**	**2.5**	**2.2**	**1.5**	**1.7**	**2.5**	**2.7**	**1.8**	**2**	**2.7**	**2**	**1.2**	

Approved in Academic Council held on 25.10.2018

IT Workshop Lab

COURSE CODE: 18B17CI372

COURSE CREDITS: 2

CORE/ELECTIVE: CORE

: 0-0-4

Pre-requisite: None

Course Objectives:

1. To introduce the students with the basic features of Matlab for problem solving
2. To introduce the students about the Mathematical functions like matrix generation and Plotting with multiple data sets, line styles and colors.
3. To introduce the students about the Array operations and solving Linear equations in Matlab.
4. To introduce the students about the control flow and operators using if-end structures and loops.
5. To introduce the students about the writing M-file scripts and Debugging M-files

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO1	Writing fundamental programs in Matlab, creating variables and mathematical functions	Familiarity
CO2	Programming the fundamentals concepts of basic Plotting consisting of simple and multiple data sets in one plot	Usage
CO3	Understand how to program matrix operations, array operations and how to solve the system of linear equations	Assessment
CO4	Understand how to program M-file scripts , M- file functions, Input –output Arguments	Assessment
CO5	Program control flow operators, loops, flow structures and debugging M-files	Assessment

List of Experiments

S.No	Description	Hours
1	1. Create variable, pounds, to store a weight in pounds. Convert this to kilograms and assign the result to variable kilos. The conversion factor is 1 kilogram = 2.2 pounds. 2. The combined resistance RT of three resistors R1, R2, and R3 in parallel is given by	**2**
	$RT = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}}$ Create variables for the three resistors and store values in each, and then calculate the combined resistance.	
2	Write a MATLAB program to calculate the following expression and round the answers to the nearest integer. a) z = 5x2 + y2 where x=2, y=4 b) z = 4cos(x)+ j6sin(x) where x=π/4 c) z = 3sin(x)+4cos(x)+3ey where x=π/3 , y=2 d) y=sin(x) / x where $0 \leq x \leq 2\pi$ 2. Solve the following system x + y - 2z =	**2**

	3 2x + y = 7 x + y - z = 4	
3	1. Write a program for three bits parity generator using even-parity bit. 2. Write a program to convert a three bits binary number into its equivalent gray code. 3. if q=[1 5 6 8 3 2 4 5 9 10 1],x=[3 5 7 8 3 1 2 4 11 5 9], then: a) find elements of (q) that are greater than 4. b) find elements of (q) that are equal to those in (x). c) find elements of (x) that are less than or equal to 7. 4. If x=[10 3 ; 9 15], y=[10 0; 9 3], z=[-1 0; -3 2], what is the output of the following statements: a) v = x > y b) w = z >= y c) u = ~z & y d) t = x & y < z	**2**
4	1.Plot sin(x) on the interval [-pi,pi] using spacing 0.5, 0.1 and 0.01 between the points where you will sample the function. (This will change the resolution). Experiment with the hold on command. 2. Attach labels to the axis of the previous plot and give a title to the graph. 3. Plot 5 cos(x2+1) on [-2pi,2pi]. Note that the squaring operation will require you to use the dot . in order for the squaring operation to act on each element individually. However, the addition operation (+) automatically acts on elements individually.	**2**
5	1. Type x=[1 2 3] y =[4 5 6] a=2 x+y x-y a*x and observe what happens. If want to apply an operation such as squaring each element in a matrix we have to use a dot . before the operation we wish to apply. Type the following commands in MATLAB. x=1:10 x.^2 A=[1 2 3 ; 4 5 6 ; 7 8 9] A.^2 A^2 and observe the result. The dot allows us to do operations element wise.	**2**

	All built-in functions such as sin, cos, exp and so on automatically act elementwise on a matrix. Type y=[0 1/4 1/2 3/4 1] y=pi*y sin(y) and observe the result. 2. Create a array x with 10 elements x=[1 2 3 4 5 6 7 8 9 10] We can also create this vector by typing x=1:10. The vector (1 1.1 1.2 1.3 1.4 1.5) can be created by typing x=[1 1.1 1.2 1.3 1.4 1.5] or by typing x=1:0.1:1.5. Matrices can be created according to the following example. The matrix A= $\begin{pmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{pmatrix}$ is created by typing A=[1 2 3 ; 4 5 6; 7 8 9], i.e., rows are separated with semi-colons. If we want to use a specific element in a vector or a matrix, study the following example: Example: x=[10 20 30] A=[1 2 3 ; 4 5 6 ; 7 8 9] x(2) A(3,1) Here we extracted the second element of the vector by typing the variable and the position within parentheses. The same principle holds for matrices; the first number specifies the row of the matrix, and the second number specifies the column of the matrix. Note that in MATLAB the first index of a vector or matrix starts at 1, not 0 as is common with other programming languages.	
6	1. A Pythagorean triple is a set of positive integers (a,b,c) such that a2 + b2 = c2. Write a function ispythag that will receive three positive integers (a, b, c in that order) and will return 1 for true if they form a Pythagorean triple, or 0 for false if not. 2. Whether a storm is a tropical depression, tropical storm, or hurricane is determined by the average sustained wind speed. In miles per hour, a storm is a tropical depression if the winds are less than 38 mph. It is a tropical storm if the winds are between 39 and 73 mph, and it is a hurricane if the wind speeds are > = 74 mph. Write a script that will prompt the user for the wind speed of the storm, and will print which type of storm it is.	**2**
7	1. Write a script that will prompt the user for N integers, and then write the positive numbers (>= 0) to an ASCII file called pos.dat and the negative numbers to an ASCII file called neg.dat. Error-check to make sure that the user enters N integers. 2. Write a script that will continue prompting the user for positive numbers, and storing them in a vector variable, until the user types a negative number. 3. Write a script that will use the menu function to present the user with choices for functions fix, floor, and ceil. Error-check by looping to display the menu until the user pushes one of the buttons (an error could occur if the user clicks the X on the menu box rather than pushing one of the buttons). Then, generate a random number and print the result of the user‟s function choice of that number (e.g., fix(5)).	2

8	1. Write a "currency exchange program" similar to the one in Example 1 which can handle two different exchange rates, exchange_rate1 = 0.5 and exchange_rate2 = 0.25. Design the program to first ask for the amount in dollars and then ask the user which rate (represented by the numbers 1 and 2 respectively) he/she wants. Let the program return the amount in the requested foreign currency. 2. Write a program that approximates PI by computing the sum . The more terms you keep in the summation, the more accurate your answer will be. (In fact, the series converges to PI as m goes to infinity.) See how many terms you need to approximate PI with 5 decimals. (Note: This is by no means the most efficient way to approximate PI, but the formula is quite beautiful...) 3. Use the sum given in Exercise 2 to approximate PI using 10, 100, 1000, 10000 and 100000 terms. For each of these numbers, compute the error of the approximation. Plot the error as a function of the number of terms used in the sum.	2
9	1. In Europe daylight time starts on the last Sunday of March and ends on the last Sunday of October. Write a function that determines whether a given daynumber is in the summertime period or in the wintertime period of the Daylight Saving Time 2. Write a function that will receive the radius of a circle and will print both the radius and diameter of the circle in a sentence format. This function will not return any value; it simply prints	**2**
10	1. Write a program to calculate and print the area and circumference of a circle. There should be one script and three functions to accomplish this (one that prompts for the radius, one that calculates the area and circumference, and one that prints). 2. The lump sum S to be paid when interest on a loan is compounded annually is given by S = P(1 + i)n, where P is the principal invested, i is the interest rate, and n is the number of years. Write a program that will plot the amount S as it increases through the years from 1 to n. The main script will call a function to prompt the user for the number of years (and error-check to make sure that the user enters a positive integer). The script will then call a function that will plot S for years 1 through n. It will use 0.05 for the interest rate and $10,000 for P.	**2**

11	1. Write a script that will prompt the user for a temperature in degrees Celsius, and then an F for Fahrenheit or K for Kelvin. The script will print the corresponding temperature in the scale specified by the user. For example, the output might look like this: Enter the temp in degrees C: 29.3 Do you want F or K? F The temp in degrees F is 84.7 The format of the output should be exactly as specified here. The conversions are: F = 9/5 *C+32 K = C+273.15 2. Write a function to calculate the volume and surface area of a hollow cylinder. It receives as input arguments the radius of the cylinder base and the height of the cylinder. The volume is given by Π r2 h, and the surface area is 2 Π r h. 3. Hurricanes are categorized based on the winds. The following table shows the category number for hurricanes with varying wind ranges and what the storm surge is (in feet above normal).	**2**
	1 74–95 4–5 2 96–110 6–8 3 111–130 9–12 4 131–155 13–18 5 >155 >18 $\pi \approx 4\sum_{k=0}^{m} \frac{(-1)^k}{2k+1}$ Write a function that will receive as an input argument the wind speed, and will return the category number and the minimum value of the typical storm surge.	

2	1. Write a function called geomser that will receive values of r and n, and will calculate and return the sum of the geometric series: 1 + r + r2 + r3 + r4 + ... + rn The following examples of calls to this function illustrate what the result should be: >> geomser(1,5) ans = 6 >> disp(geomser(2,4)) 31 2. A sound engineer has recorded a sound signal from a microphone. The sound signal was sampled, meaning that values at discrete intervals were recorded (rather than a continuous sound signal). The units of each data sample are volts. The microphone was not on at all times, however, so that data samples below a certain threshold are considered to be data values that were samples when the microphone was not on, and therefore not valid data samples. The sound engineer would like to know the average voltage of the sound signal. Write a script that will ask the user for the threshold and the number of data samples, and then for the individual data samples. The program will then print the average and a count of the valid data samples, or an error message if there were no valid data samples. An example of what the input and output would look like in the Command Window is shown: Please enter the threshold below which samples will be considered to be invalid: 3.0 Please enter the number of data samples to be entered: 7 Please enter a data sample: 0.4 Please enter a data sample: 5.5 Please enter a data sample: 5.0 Please enter a data sample: 2.1 Please enter a data sample: 6.2 Please enter a data sample: 0.3 Please enter a data sample: 5.4 The average of the 4 valid data samples is 5.53 volts	2
13	1. Create a vector of five random integers, each in the range from –10 to 10. Perform each of the following two ways: using built-in functions, and also using loops (with if statements if necessary): Subtract 3 from each element. Count how many are positive. Get the absolute value of each element. Find the maximum. 2. Create a 3 × 5 matrix. Perform each of the following two ways: using built-in functions, and also using loops (with if statements if necessary): Find the maximum value in each column. Find the maximum value in each row. Find the maximum value in the entire matrix. 3. Write a script that will print the following multiplication table: 1 2 4 3 6 9 4 8 12 16 4. 5 10 15 20 25	2

14	1. Biomedical engineers are developing an insulin pump for diabetics. To do this, it is important to understand how insulin is cleared from the body after a meal. The concentration of insulin at any time t is described by the equation C = C0 e−30t/m where C0 is the initial concentration of insulin, t is the time in minutes, and m is the mass of the person in kg. Write a script that will graphically show how the weight of the person influences the time for insulin to be cleared from the body. It will show in a 2 × 1 subplot the concentration of insulin for two subjects, one who weighs 120 pounds, and one who weighs 300 pounds. For both, the time should increment from 0 to 4 minutes in steps of 0.1 minute, and the initial concentration should be 85. The concentration over time will be shown in each subplot, and the weight of the person should be in the title. The conversion factor is 1 pound = 0.4536 kg. In order to better compare, use consistent axes for both plots. 2. Sales (in millions) from two different divisions of a company for the four quarters of 2006 are stored in vector variables, for example, div1 = [4.2 3.8 3.7 3.8]; div2 = [2.5 2.7 3.1 3.3]; Using subplot, show side-by-side the sales figures for the two divisions. What kind of graph shows this in the best way? Why? In one graph, compare the two divisions. What kind of graph shows this in the best way? Why?	**2**
15	1. For the following matrices A, B, and C: A B C 1 4 2 1 3 3 2 5 3 2 1 5 6 4 1 2 3 6 0 Which are symmetric? For all square matrices, give their trace. Give the result of 3*A. Give the result of A*C. Are there any other matrix multiplications that can be performed? If so, list them. 2. Given the following matrices: A B C 3 2 1 2 1 0 0 0 5 2 1 0 1 0 1 0 3 3 0 0 1 Perform the following MATLAB operations, if they can be done. If not, explain why. A * B B * A I +A A .* I trace(A)	**2**
16	1. Write a function issquare that will receive an array argument, and will return 1 for true if it is a square matrix, or 0 for false if it is not. 2. Write a function mydiag that will receive an array argument, and will return a vector consisting of the main diagonal (without using the built- in diag function).	**2**

17	2. Write a function that will receive a square matrix as an input argument, and will return a row vector containing the diagonal of the matrix. If the function is called with a vector of two variables on the left-hand side of the assignment, the function will also return the trace of the matrix. (Note: It will return the trace only if there is two variables on the left-hand side of the assignment.) You may assume that the matrix is square. The function must preallocate the diagonal vector to the correct size. 2. Write a function randdiag that will return an n x n diagonal matrix, with random integers each in the range from low to high on the diagonal. Three arguments are passed to the function: the value of n, low, and high, in that order.	**2**
18	1. Write a function to receive a matrix and return its transpose (for more programming practice, do not use the built-in operator for the transpose). 2. We have already seen the zeros function, which returns a matrix of all 0"s. Similarly, there is a function ones that returns a matrix of all 1"s. Note: No, there aren"t functions called twos, threes, and such (just ones and zeros!). However, write a fives function that will receive two arguments for the number of rows and columns and will return a matrix with that size of all 5"s.	**2**
19	1. The function magic(n) returns an n n magic matrix, which is a matrix for which the sum of all rows, columns, and the diagonal are the same. Investigate this built-in function. 2. The function pascal(n) returns an n n matrix made from Pascal"s triangle. Investigate this built-in function, and then write your own.	**2**
20	1. For the following 2 x 2 system of equations: 3x1 + 2x2 = 4 x1 = 2 Write this in matrix form. Using the method for 2 x 2 systems, find the determinant D. Use D to find the inverse of A. Use the Gauss elimination method to find the solution. Use the Gauss-Jordan method to solve. Check your work in MATLAB. 2. For the following set of equations: 2x1 + 2x2 + x3 = 2 x 2 + 2x3 = 1 x1 + x2 + 3x3 = 3 Put this in the augmented matrix [A|b]. Solve using Gauss. Solve using Gauss-Jordan. In MATLAB, create the matrix A and vector b. Find the inverse and determinant of A. Solve for x.	**2**
21	1. Solve the simultaneous equations x – y = 2 and x2 + y = 0 using solve. Plot the corresponding functions, y = x – 2 and y = –x2, on the same graph with an x range from –5 to 5. 2. For the following set of equations: 2x1 + 2x2 + x3 = 2 x 2 + 2x3 = 1	**2**

	x1 + x2 + 3x3 = 3 In MATLAB, create the coefficient matrix A and vector b. Solve for x using the inverse, using the built-in function. Create the augmented matrix [A|b] and solve using the rref function. Write this in symbolic form and solve using the solve function. From the symbolic solution, create a vector of the numerical (double) equivalents	
22	1. Rewrite the following system of equations in matrix form: 4x1 − x2 + 3x4 = 10 −2x1 + 3x2 + x3 − 5x4 = −3 x1 + x2 − x3 + 2x4 = 2 3x1 + 2x2 − 4x3 = 4 Set it up in MATLAB and use any method to solve. 2. For the following 2 2 system of equations: −3x1 + x2 = −4 −6x1 + 2x2 = 4 In MATLAB, rewrite the equations as equations of straight lines and plot them to find the intersection. Solve for one of the unknowns and then substitute into the other equation to solve for the other unknown. Find the determinant D. How many solutions are there? One? None? Infinite?	**2**
23	1. For the following 2 x 2 system of equations: −3x1 + x2 = 2 −6x1 + 2x2 = 4 Rewrite the equations as equations of straight lines and plot them to find the intersection. Solve for one of the unknowns and then substitute into the other equation to solve for the other unknown. Find the determinant D. How many solutions are there? One? None? Infinite? 2. Write a function to return the determinant of a 2 x 2 matrix. 3. Write a function to return the inverse of a 2 x 2 matrix.	**2**
24	1. Write a script that will do the following. Create two vectors with 20 random integers in each; in one the integers should range from 1 to 5, and in the other from 1 to 500. For each vector, would you expect the mean and median to be approximately the same? Would you expect the standard deviation of the two vectors to be approximately the same? Answer these questions, and then use the built-in functions to find the minimum, maximum, mean, median, standard deviation, and mode of each. Do a histogram for each in a subplot. Run the script a few times to see the variations. 2. Write a function that will return the mean of the values in a vector, not including the minimum and maximum values. Assume that the values in the vector are unique. It is OK to use the built-in mean function. To test this, create a vector of 10 random integers, each in the range from 0 to 50, and pass this vector to the function.	**2**

25	1. A student missed one of four exams in a course, and the professor decided to use the average of the other three grades for the missed exam grade. Which would be better for the student: the mean or the median if the three recorded grades were 99, 88, and 95? What if the grades were 99, 70, and 77? 2. A weighted mean is used when there are varying weights for the data values. For a data set given by x = {x1, x2, x3, x4, . . . , xn} and corresponding weights for each xi, w = {w1, w2, w3, w4, . . . , wn}. Write a function that will receive two vectors as input arguments: one for the data values and one for the weights, and will return the weighted mean.	**2**
26	1. DNA is a double-stranded helical polymer that contains basic genetic information in the form of patterns of nucleotide bases. The patterns of the base molecules A, T, C, and G encode the genetic information. Construct a cell array to store some DNA sequences as strings, such as TACGGCAT ACCGTAC and then sort these alphabetically. Next, construct a matrix to store some DNA sequences of the same length and then sort them alphabetically. 2. Write a function that will receive two arguments: a vector and a character (either „a" or „d") and will sort the vector in the order specified by the character (ascending or descending).	**2**
27	1. Write a function matsort to sort all the values in a matrix (decide whether the sorted values are stored by row or by column). It will receive one matrix argument and return a sorted matrix. Do this without loops, using the built-in functions sort and reshape. For example: >> mat mat = 4 5 2 1 3 6 7 8 4 9 1 5 >> matsort(mat) ans = 1 4 6 1 4 7 2 5 8 3 5 9 2. Write a function that will receive two arguments: a vector and a character (either „a" or„d") and will sort the vector in the orderspecified by the character (ascending or descending).	**2**

8	1. Find the roots of the equation f(x) = 0 for the following function. Also, create x and y vectors and plot this function in the range from –3 to 3 in order to visualize the solution. f(x) = 3x2 - 2x – 5 2. Evaluate the polynomial expression 3x3 + 4x2 + 2x – 2 at x = 4, x = 6, and x = 8. 3. Sometimes the roots of polynomial equations are complex numbers. For example, create the polynomial row vector variable pol: >> pol = [3 6 5]; Use the roots function to find the roots. Also, use ezplot(poly2sym(pol)) to see a plot. Then, change the last number in pol from 5 to –7 and again find the roots and view the plot.	**2**
Total Lab hours		**56**

Suggested Books/Resources:

1. Stormy Attaway, Matlab: a Practical Introduction to Programming and Problem Solving, Elsevier
2. Essentials of MATLAB Programming Stephen J. Chapman , 2005
3. MATLAB for Engineers Holly Moore, 2007
4. MATLAB Programming for Engineers Stephen J. Chapman , 1999
5. Matlab, An Introduction With Applications Amos Gilat , 2003
6. MATLAB Guide 2000
7. https://nptel.ac.in/courses/103106118/
8. Link to topics related to course:
   i. https://www.mccormick.northwestern.edu/documents/students/undergraduate/introduction-to-matlab.pdf
   ii. https://www.math.utah.edu/~wright/misc/matlab/matlabintro.html
   iii. https://web.stanford.edu/class/ee254/software/using_ml.pdf

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Attendance	15 Marks
4	Lab Assessment	45 Marks
	Total	100 marks

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Average
CO1	3	3	3	1	1	2	1	2	1	2	2	2	**1.9**
CO2	3	3	3	1	3	2	1	2	1	2	3	2	**2.2**
CO3	3	3	3	3	2	1	2	2	2	2	3	2	**2.3**
CO4	3	3	3	3	2	1	2	2	2	2	3	2	**2.3**
CO5	3	3	3	3	2	1	2	2	2	2	2	2	**2.3**
Average	**3**	**3**	**3**	**2.2**	**2**	**1.4**	**1.6**	**2**	**1.6**	**2**	**2.6**	**2**	

Approved in Academic Council held on 25.10.2018

Discrete Computational Mathematics

COURSE CODE: 18B11CI414

COURSE CREDITS: 3

CORE/ELECTIVE: COR

L-T-P: 3-0-0

Pre-requisite: Basic Mathematics Algebra

Course Objectives

1. To simplify and evaluate any logical expression and to express logical statements in terms of logical connectives, predicates and quantifiers.
2. Use of various set operations, relations and functions concept to solve applied problems.
3. To solve counting problems using elementary counting techniques.
4. To learn and perform various graphs and trees terminologies, traversals & their applications.
5. Problem solving using recursion and recurrence relations by analyzing algorithms.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Students will be able to express logical statements in terms of logical connectives, predicates and quantifiers.	Familiarity
CO-2	Students will be able to apply various proving techniques such as direct, indirect proofs, mathematical induction, etc.	Assessment
CO-3	They will learn basic set operations along with relations & functions with their types and usage.	Familiarity
CO-4	They will be familiar with graph & tree terminologies along with their various applications in computer science.	Familiarity
CO-5	Students will be able to solve counting problems using permutation, combinations techniques.	Assessment
CO-6	They will learn about algebraic structures such as group, abelian group, rings, integral domain, fields, etc	Familiarity
CO-7	Students will be able to analyze and solve various algorithms using recurrence relation methods	Assessment

Course Contents:

Unit	Contents	Lectures required
1	Introduction and Applications of Discrete Mathematics, Mathematical Logic: Propositional & Predicate; Quantifiers, Proving Techniques: Direct Proof, Contra positive, Contradiction, Principle of Mathematical Induction; Pigeonhole Principle	6
2	Sets, Types of Sets, Various set operations, Venn Diagrams, Identities in sets, Principle of Inclusion & Exclusion	3
3	Relations: Types & Representation; Properties of Binary Relations, Equivalence Relations, Partial Ordering Relations, Partitions. Functions, Types of Functions, inverse of function, composition of functions.	5
4	Graph, Graph Terminologies, Types of Graphs, Paths & Circuits, Euler & Hamiltonian Graphs, Planar Graphs, Graph Traversals: Breadth First Search & Depth First Search, Shortest Path Algorithms.	7

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5	Trees, Tree Terminologies, Types of Trees: General, Binary, Strictly Binary, Full & Complete Binary Tree; Tree Traversals, Binary Search Tree, AVL Trees.	7
6	Basic Counting Techniques, The Sum and Product Rule, Permutations, Combinations, Generation of Permutations and Combinations	4
7	Properties of Algebric Structures, Semigroups, Monoids, Groups, Abelian Groups, Subgroups, Homomorphism & Isomorphism of Groups, Rings, its characteristics & its types, Integral Domain & Fields.	6
8	Recurrence Relations, Linear Recurrence Relations with constant coefficients (homogeneous & non-homogeneous) with their solving techniques.	4
Total lectures		**42**

Suggested Text Book(s):

a. C.L. Liu & D.P. Mohapatra, "Elements of Discrete Mathematics: A Computer Oriented Approach", 4th Edition, TMH

b. Kenneth H. Rosen, "Discrete Mathematics and its Applications", 7th Edition, TMH

Suggested Reference Book(s):

1. B. Kolman, R. Busby & S.C. Ross, "Discrete Mathematical Structures", 6th Edition, Pearson Education.
2. S. Lipschutz & M. Lipson, "Discrete Mathematics", 3rd Edition, TMH.
3. J.P. Tremblay & R. S. Manohar, "Discrete Mathematical Structures with Applications to Computer Science, TMH, New York 1997.
4. Richard Hammack, "Book of Proof", 2nd Edition, VCU Mathematics Text Book Series

Other useful resource(s):

1. Link to NPTEL course contents: https://onlinecourses.nptel.ac.in/noc18_cs53/preview
2. Link to topics related to course:
   i. https://www.youtube.com/watch?v=xlUFkMKSB3Y
   ii. https://www.youtube.com/watch?v=RMLR2JHHeWo
   iii. https://www.youtube.com/watch?v=9AUCdsmBGmA
   iv. https://www.youtube.com/watch?v=7cTWea9YAJE

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

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Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Discrete Computational Mathematics)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	2	1	2	2	2	1	2	3	3	2	**2.2**
CO-2	3	3	3	2	2	2	3	2	2	1	2	2	**2.3**
CO-3	3	3	2	1	1	3	3	3	3	3	1	1	**2.3**
CO-4	3	2	2	1	2	2	2	2	1	2	1	2	**1.8**
CO-5	3	2	2	1	2	3	3	2	1	3	2	1	**2.1**
CO-6	3	2	3	1	1	3	2	1	1	3	2	1	**1.9**
CO-7	3	3	2	1	1	3	3	1	3	3	3	1	**2.3**
Average	**3**	**2.6**	**2.3**	**1.1**	**1.6**	**2.6**	**2.6**	**1.7**	**1.9**	**2.6**	**2**	**1.4**	

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Modeling and Simulation Techniques

COURSE CODE: 18B11CI413

COURSE CREDITS: 2

CORE/ELECTIVE: CORE

L-T-P: 2-0-0

Pre-requisite: Discrete Mathematics, Algorithm, Software Engineering

Course Objectives:

1. Student will model real-world systems and implement the model as a computer program
2. Student will learn model design and development comparison to analytical models.
3. Student will learn important methods of computing and statistics.
4. Student will learn important techniques of real world project development and management.
5. Student will learn to evaluate the performance of real-world systems by analyzing the output of the model under various conditions..

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	To learn the basic concepts, applications and terminology of computer simulation and modeling.	Familiarity
CO-2	To learn statistical methods of estimation and testing and other relevant concepts	Technical
CO-3	To explain the working and applications of different types of simulation such as Monte Carlo, VS. Discrete Event	Technical
CO-1	You will learn how to model a system and the execution of simulation tools.	Technical
CO-2	You will learn to analyze input data, its parameters, and the use of random number in a typical simulation study.	Technical
CO-3	Student will learn different techniques for the Verification and Validation of a simulation study	Technical

Course Contents:

Unit	Contents	Lectures required
1	**Introduction to Simulation and Modeling:** Simulation: Definition, Methods, Systems, Variability, Complexity, Advantages. Modelling: Definition, characteristics, description, categories.	5
2	**Statistical Concepts:** Hypothesis, Estimation, Statistical Significance, Error/Risks. Statistical tests, Bounds and Correlation. Input Data Modelling, Output Data Analysis.	5
3	**Discrete-Event Simulation, Monte Carlo Simulation:** Queuing System Model Components, Simulation Methodology, DES Example, Implementation, Arena Simulation. The Monte Carlo Method, Sensitivity Analysis	8
4	**Systems Modeling:** System Model Types, Modeling Methodologies and Tools, Analysis of Modeling and Simulation, Operation Research Methods, Coding the Model, Use of Pseudo Random Number Streams.	8
5	**Data Collection and Analysis :** Obtaining Data, Data Format, Representing Unpredictable Variability, Distributions, Bootstrapping,	8

	Fitting Statistical Distributions to Empirical Data	
6	**Verification, Validation, and Accreditation:** Definition and concepts, Difficulties, Confidence as Validity. Conceptual Model Validation, Data Validation, White-Box Validation, Black-Box Validation, Experimentation Validation, Solution Validation, Independent Verification and Validation	**8**
Total lectures		**42**

Suggested Text Book(s):

1. Modeling and Simulation: Exploring Dynamic System Behavior, Authors: Birta, Louis G., Arbez, Gilbert
2. Simulation (5th Edition) , Authors: Sheldon Ross.

Suggested Reference Book(s):

1. MODELING AND SIMULATION FUNDAMENTALS Theoretical Underpinnings and Practical Domains by John A. Sokolowski Catherine M. Banks.
2. Science in the Age of Computer Simulation by ERIC WINSBERG
3. Modeling and Simulation: The Computer Science of Illusion. By Raczynski, S..

Other useful resource(s):

1. Link to NPTEL course contents: https://nptel.ac.in/courses/106104019/
2. Link to topics related to course:
   i. https://nptel.ac.in/courses/106104019/1
   ii. https://nptel.ac.in/courses/106104019/4
   iii. https://nptel.ac.in/courses/106104019/26
   iv. https://nptel.ac.in/courses/106104019/2Ev

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Data Simulation and Modeling Techniques)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	3	1	2	1	3	3	2	3	3	3	**2.5**

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CO-2	3	3	3	3	2	2	3	3	2	3	3	3	**2.8**
CO-3	3	3	3	3	2	2	3	3	2	3	3	3	**2.8**
CO-4	3	3	3	3	2	2	3	3	2	3	3	3	**2.8**
CO-5	3	3	3	3	2	2	3	3	2	3	3	3	**2.8**
CO-6	3	3	3	1	2	3	3	3	3	3	3	3	**2.8**
Average	**3**	**3**	**3**	**2.3**	**2**	**2**	**3**	**3**	**2.2**	**3**	**3**	**3**	

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Operating System

COURSE CODE: 18B11CI411

COURSE CREDITS: 3

CORE/ELECTIVE: CORE

L-T-P: 3-0-0

Pre-requisite: C/C++

Course Objectives:

1. To learn the mechanisms of OS to handle processes and threads and their communication.
2. To learn the mechanisms involved in memory management in contemporary OS.
3. To gain knowledge on distributed operating system concepts that includes architecture, Mutual exclusion algorithms, deadlock detection algorithms and agreement protocols.
4. To know the components and management aspects of concurrency management.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	An appreciation of the role of an operating system.	Familiarity
CO-2	Create processes and threads.	Assessment
CO-3	Develop algorithms for process scheduling for a given specification of CPU utilization, Throughput, Turnaround Time, Waiting Time, Response Time.	Assessment
CO-4	For a given specification of memory organization develop the techniques for optimally allocating memory to processes by Increasing memory utilization and for improving the access time	Assessment
CO-5	Design and implement file management system.	Assessment
CO-6	For a given I/O devices and OS (specify) develop the I/O management functions in OS as part of a uniform device abstraction by performing operations for synchronization between CPU and I/O controllers. .	Usage

Course Contents:

Unit	Contents	Lectures required
1	**Introduction:** Concept of Operating Systems, Generations of Operating systems, Types of Operating Systems, OS Services, System Calls, Structure of an OS - Layered, Monolithic, Microkernel Operating Systems, Concept of Virtual Machine. Case study on UNIX and WINDOWS Operating System.	**4**
2	**Process:** Definition, Process Relationship, Different states of a Process, Process State transitions, Process Control Block (PCB), Context switching. **Thread:** Definition, Various states, Benefits of threads, Types of threads, Concept of multithreads.	**4**
3	**Process Scheduling:** Foundation and Scheduling objectives, Types of Schedulers, Scheduling criteria: CPU utilization, Throughput, Turnaround Time, Waiting Time, Response Time; Scheduling algorithms: Pre-emptive and Non pre-emptive, FCFS, SJF, Priority, RR; Multiprocessor scheduling: Real Time scheduling: RM and EDF	**4**
4	**Inter-process Communication:** Critical Section, Race Conditions, Mutual	**10**

	Exclusion, Hardware Solution, Strict Alternation, Peterson‟s Solution, Lamport‟s Bakery Algorithm, The Producer\ Consumer Problem, Semaphores, Event Counters, Monitors, Message Passing, Classical IPC Problems: Reader‟s & Writer Problem, Dinning Philosopher Problem etc.	
5	**Deadlocks:** Definition, Necessary and sufficient conditions for Deadlock, Deadlock Prevention, Deadlock Avoidance: Banker‟s algorithm, Deadlock detection and Recovery.	**4**
6	**Memory Management:** Basic concept, Logical and Physical address map, Memory allocation: Contiguous Memory allocation – Fixed and variable partition–Internal and External fragmentation and Compaction; Paging: Principle of operation – Page allocation – Hardware support for paging, Protection and sharing, Disadvantages of paging.	**6**
7	**Virtual Memory**: Basics of Virtual Memory – Hardware and control structures – Locality of reference, Page fault, Working Set , Dirty page/Dirty bit – Demand paging, Page Replacement algorithms: Optimal, First in First Out (FIFO), Second Chance (SC), Not recently used (NRU) and Least Recently used (LRU).	**5**
8	**I/O Hardware:** I/O devices, Device controllers, Direct memory access Principles of I/O Software: Goals of Interrupt handlers, Device drivers, Device independent I/O software, Secondary-Storage Structure: Disk structure, Disk scheduling algorithms. **File Management:** Concept of File, Access methods, File types, File operation, Directory structure, File System structure, Allocation methods (contiguous, linked, indexed), Free-space management (bit vector, linked list, grouping), directory implementation (linear list, hash table), efficiency and performance. **Disk Management:** Disk structure, Disk scheduling - FCFS, SSTF, SCAN, C-SCAN, Disk reliability, Disk formatting, Boot-block, Bad blocks.	**5**
Total lectures		**42**

Suggested Text Book(s):

1. “Operating System Concepts” 9th Edition by Silberschatz, Peter Galvin, Greg Gagne, Wiley Asia Student Edition.
2. “Operating Systems: Internals and Design Principles” 9th Edition, William Stallings, Pearson.

Suggested Reference Book(s):

1. “Operating System: A Design-oriented Approach, 1st Edition by Charles Crowley, Irwin Publishing
2. “Operating Systems: A Modern Perspective” 2nd Edition by Gary J. Nutt, Addison-Wesley
3. Design of the Unix Operating Systems, 8th Edition by Maurice Bach, Prentice-Hall of India.
4. Understanding the Linux Kernel, 3rd Edition, Daniel P. Bovet, Marco Cesati, O'Reilly and Associates

Other useful resource(s):

1. Link to NPTEL course contents: https://nptel.ac.in/courses/106108101//
2. Link to topics related to course:
   i. https://nptel.ac.in/courses/106106144/
   ii. https://www.class-central.com/course/udacity-introduction-to-operating-systems-3419

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Operating System)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	3	2	2	3	2	2	2	3	1	3	**2.4**
CO-2	3	3	3	2	3	2	3	2	2	3	1	3	**2.5**
CO-3	3	3	3	2	2	3	1	2	3	3	1	3	**2.4**
CO-4	3	3	3	2	3	3	2	2	3	3	1	3	**2.6**
CO-5	3	3	3	2	3	3	2	2	3	3	1	3	**2.6**
CO-6	3	3	3	2	3	3	2	2	2	3	1	3	**2.5**
Average	**3**	**3**	**3**	**2**	**2.7**	**2.8**	**2**	**2**	**2.5**	**3**	**1**	**3**	

Design and Analysis of Algorithms

COURSE CODE: 18B11CI412

COURSE CREDITS: 3

CORE/ELECTIVE: CORE

L-T-P: 3-0-0

Pre-requisite: Data structure and algorithms

Course Objectives:

1. Analyze the asymptotic performance of algorithms.
2. Write rigorous correctness proofs for algorithms.
3. Demonstrate a familiarity with major algorithms and data structures.
4. Apply important algorithmic design paradigms and methods of analysis.
5. Synthesize efficient algorithms in common engineering design situations.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	For a given algorithms analyze worst-case running times of algorithms based on asymptotic analysis and justify the correctness of algorithms.	Technical
CO-2	Describe the greedy paradigm and explain when an algorithmic design situation calls for it. For a given problem develop the greedy algorithms.	Technical
CO-3	Describe the divide-and-conquer paradigm and explain when an algorithmic design situation calls for it. Synthesize divide-and-conquer algorithms. Derive and solve recurrence relation.	Technical
CO-4	Describe the dynamic-programming paradigm and explain when an algorithmic design situation calls for it. For a given problems of dynamic-programming and develop the dynamic programming algorithms, and analyze it to determine its computational complexity.	Technical
CO-5	For a given model engineering problem model it using graph and write the corresponding algorithm to solve the problems.	Technical
CO-6	Explain the ways to analyze randomized algorithms (expected running time, probability of error).	Technical
CO-7	Explain what an approximation algorithm is. Compute the approximation factor of an approximation algorithm (PTAS and FPTAS).	Technical

Course Contents:

Unit	Contents	Lectures required
1	Introduction: Characteristics of algorithm. Analysis of algorithm: Asymptotic analysis of complexity bounds – best, average and worst-case behavior; Performance measurements of Algorithm, Time and space trade-offs, Analysis of recursive algorithms through recurrence relations: Substitution method, Recursion tree method and Masters" theorem. Examples: Binary counter, Recursive Fibonacci in LogN	**10**
2	Fundamental Algorithmic Strategies: Brute-Force, Greedy, Dynamic Programming, Branch and Bound and Backtracking methodologies for the design	**8**

	of Algorithms; Illustrations of these techniques for Problem- Solving , Bin Packing, Knap Sack TSP. Heuristics characteristics and their application domains. Examples: Greedy and dynamic scheduling, Hoffman encoding, Dynamic programming: Longest common subsequence, Matrix chain multiplication, Dynamic programming: Bin packing, Knapsack, Dynamic programming: TSP, Branch and Bound TSP, Backtracking: SAT, Maze Sudoku solver, 8 queen	
3	Graph and Tree Algorithms: Traversal algorithms: Depth First Search (DFS) and Breadth First Search (BFS); Shortest path algorithms, Transitive closure, Minimum Spanning Tree, Topological sorting, Network Flow Algorithm. Examples: Best first search, Binomial heap MST: Prims, Kruskal, Fibonacci heap MST: Tarjan, Lazy decrease key implementation and Dijkstra, MaxFlow/ MinCut Ford-Fulkersion	**8**
4	Tractable and Intractable Problems: Computability of Algorithms, Computability classes – P, NP, NP-complete and NP-hard. Cook‟s theorem, Standard NP-complete problems and Reduction techniques. Examples: Set Cover, Vertex cover, Map coloring, chromatic number	**8**
5	Advanced Topics: Approximation algorithms, Randomized algorithms, Class of problems, beyond NP – P SPACE, Examples: Approximate matrix inversion, Randomized Eigen vector computation	**8**
Total lectures		**42**

Suggested Text Book(s):

1. Rntroduction to Algorithms, 4TH Edition, Thomas H Cormen, Charles E Lieserson, Ronald L Rivest and Clifford Stein, MIT Press/McGraw-Hill.
2. Fundamentals of Algorithms – E. Horowitz et al.

Suggested Reference Book(s):

1. Algorithm Design, 1ST Edition, Jon Kleinberg and ÉvaTardos, Pearson.
2. Algorithm Design: Foundations, Analysis, and Internet Examples, Second Edition,
3. Michael T Goodrich and Roberto Tamassia, Wiley.
4. Algorithms -- A Creative Approach, 3RD Edition, UdiManber, Addison-Wesley, Reading, MA.

Other useful resource(s):

1. Link to NPTEL course contents: https://onlinecourses.nptel.ac.in/noc18_cs20/preview
2. Link to topics related to course:
   i. https://nptel.ac.in/courses/106101060/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Approved in Academic Council held on 25.10.2018

Course outcomes (Design and Analysis of Algorithms)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	3	3	3	1	1	3	3	3	1	3	**2.5**
CO-2	2	2	2	2	2	1	1	1	2		1	2	**1.6**
CO-3	3	3	3	3	3	1	1	1	3	1	1	3	**2.2**
CO-4	2	2	2	2	2	2	1	1	2		2	2	**1.8**
CO-5	2	2	2	2	2	3	1	1	2	2	2	2	**1.9**
CO-6	2	2	2	2	2	2	1	2	2	2	2	2	**1.9**
CO-7	2	2	2	2	2	2	1	2	2	2	2	2	**1.9**
Average	**2.3**	**2.3**	**2.3**	**2.3**	**2.3**	**1.7**	**1**	**1.6**	**2.3**	**2**	**1.6**	**2.3**	

Approved in Academic Council held on 25.10.2018

Python Programming with Raspberry PI

COURSE CODE:18B11CI315

COURSE CREDITS: 3

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

Raspberry Pi chose Python as its teaching language of choice to encourage a new generation of programmers to learn how to program. This approachable book serves as an ideal resource for anyone wanting to use Raspberry Pi to learn to program and helps you get started with the Python programming language. Aimed at first-time developers with no prior programming language assumed, this beginner book gets you up and running.

1. Covers variables, loops, and functions
2. Addresses 3D graphics programming
3. Walks you through programming Mine craft
4. Zeroes in on Python for scripting.

Course Outcomes:

S.No.	Course outcomes	Level of Attainment
CO-1	Introducing Raspberry pi: what is programming, why raspberry pi, introducing the raspberry pi	Familiarity
CO-2	Introducing Python: Scripting vs. a Programming Language, The Python Philosophy, Getting Started with Python, Python basics, Programming with Python	Assessment
CO-3	Graphical Programming: Graphical User Interface (GUI) Programming, Adding Controls, Creating a Web Browser, Adding Window Menus, the web bolt, Calculating the Distance of the Point from the Light Source.	Assessment
CO-4	Creating games: building a game, installing Pi game, creating a worlds, detecting collisions, adding sound, adding scenery, adding the finishing touches, realistic game physics, Calculating Reflecting Angles, Building the 3D Model, Speaking to Your Pi.	Usage
CO-5	Networked Python: Understanding Hosts, Ports, and Sockets, Locating Computers with IP Addresses, Building a Chat Server, Tweeting to the World.	Familiarity
CO-6	Multimedia: Using Pi Audio to Get Sound into Your Computer, Recording the Sound, Speaking to Your Pi, Making Movies, Adding Computer Vision Features with Open CV, Creating Live Streams.	Usage

Course Contents:

Unit	Contents	Lecture required
1	Introduction: what is programming, why raspberry pi, introducing the raspberry pi	**3**
2	Introducing Python: Scripting vs. a Programming Language, The Python Philosophy, Getting Started with Python, Python basics, Programming with Python	**9**
3	Graphical Programming: Graphical User Interface (GUI) Programming, Adding Controls, Creating a Web Browser, Adding Window Menus, the web bolt, Calculating the Distance of the Point from the Light Source.	**9**
4	Creating games: building a game, installing Pi game, creating a worlds, detecting collisions, adding sound, adding scenery, adding the finishing touches, realistic game physics, Calculating Reflecting Angles, Building the 3D Model, Speaking to Your Pi.	**1**
5	Networked Python: Understanding Hosts, Ports, and Sockets, Locating Computers with IP Addresses, Building a Chat Server, Tweeting to the World.	**6**
6	Multimedia: Using Pi Audio to Get Sound into Your Computer, Recording the Sound, Speaking to Your Pi, Making Movies, Adding Computer Vision Features with Open CV, Creating Live Streams.	**4**
7	Scripting: Getting Started with the Linux Command Line, Using the Sub process Module, Command-Line Flags, and Scripting with Networking.	**3**
8	Interfacing with hardware and testing and debugging: Setting Up Your Hardware Options, Sneed of hardware, Finding Bugs by Testing, Checking Bits of Code with Unit Tests, Using Test Suites for Regression Testing, Making Sure Your Software's Usable.	**2**
Total Lectures		**42**

Suggested Text Book(s):

1. **Learning Python with Raspberry Pi** By Alex Bradbury, Ben Everard
2. **Learn Raspberry Pi Programming with Python** By Wolfram Donat

Suggested Reference Book(s):

1. Kenneth A. Lambert, The Fundamentals of Python: First Programs, 2011, Cengage Learning, ISBN: 978-1111822705.
2. Chun, Wesley. Core python programming. Vol. 1. Prentice Hall Professional, 2001.
3. Zelle, John M. Python programming: an introduction to computer science. Franklin, Beedle& Associates, Inc., 2004.
4. Gold, Steve. "Python: Python Programming Learn Python Programming In A Day-A Comprehensive Introduction To The Basics Of Python & Computer Programming." (2016).

Other useful resource(s):

1. https://onlinecourses.nptel.ac.in/noc18_cs35/preview
2. https://nptel.ac.in/courses/106106145/
3. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-0001-introduction-to-computer-science-and-programming-in-python-fall-2016/index.htm
4. https://docs.python.org/3/tutorial/index.html

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes(2) -10 Attendance - 5

*In Test-I Paper the 20% of 15 Marks will be allocated to Introduction to Computers portion and 80% of 15 Marks will be allocated toIntroduction to Programming portion.

#In Test-II Paper the 20% of 25 Marks will be allocated tosyllabus of Test-I and 80% of 25 Marks will be allocated tofurther covered portion.

$In Test-III Paper the 40% of 30 Marks will be allocated to syllabus of Test-I+ Test-II and 60% of 30 Marks will be allocated to further covered portion.

~Internal Assessment will purely be focused on the assignments and quizzes based on Python Programming.

Course Outcomes (COs) contribution to the ProgrammeOutcomes(POs)

Course outcomes (Python Programing with Raspberry PI)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	2	3	1	2	3	3	2	1	1	1	3	**2.1**
CO-2	3	3	3	1	2	3	3	3	2	1	1	3	**2.3**
CO-3	3	3	3	1	2	3	2	3	2	1	1	3	**2.3**
CO-4	3	3	3	3	3	3	3	2	2	1	1	3	**2.5**
CO-5	3	3	3	2	2	3	3	3	2	1	1	3	**2.4**
CO-6	3	3	3	2	3	2	3	2	2	1	1	3	**2.3**
Average	**3**	**2.8**	**3**	**1.7**	**2.3**	**2.8**	**2.8**	**2.5**	**1.8**	**1**	**1**	**3**	

Object-Oriented Systems and Programming

COURSE CODE: 18B11CI311

COURSE CREDITS: 3

CORE/ELECTIVE: CORE

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

1. To use object modelling technique to analyze problem requirements, design a solution to the problem and then implement the solution in Object-Oriented Programming Language(s) or database.
2. To strengthen their problem solving ability by applying the characteristics of an object-oriented approach.
3. To strengthen ability to design and represent solutions to problems using UML notations
4. To introduce object oriented concepts in C++ and Java.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	To learn the concepts of Objects, Classes, Methods, Constructors and Destructors	Usage
CO-2	To learn the designing of complex classes: Friend Functions and Static member functions, Inline functions, constant functions.	Usage
CO-3	To learn Inheritance: Single Inheritance, Multiple Inheritance, Multi-level Inheritance, Hierarchical Inheritance and Hybrid Inheritance.	Usage
CO-4	To learn the concept of Abstract classes and interfaces	Usage
CO-5	To learn the concepts of Operator overloading and conversion function	Usage
CO-6	To learn File Handling. Writing and reading data from the file, reading and writing the objects into the file.	Usage
CO-7	To learn the Exception Handling: try --catch and finally block, making user-defined exceptions.	Usage
CO-8	To learn the Unified Modeling Language (UML): Use Case Diagrams, State Diagrams, Sequence Diagrams, Communication Diagrams, and Activity Diagrams.	Familiarity

Course Contents:

Unit	Contents	Lectures required
1	Structured versus Object-Oriented programming, Object-Oriented paradigm. Defining Objects, Classes, Data members, Member functions, Constructors and Destructors in C++. Inline Functions, Friend Functions, Constant member functions, and Static members (static data and static member functions). Function overloading, Operator overloading and Conversion functions. Using the concepts of File handling	12
2	Polymorphism and Inheritance in C++. Abstract classes, virtual function, pure virtual functions, and virtual base classes in C++.	6
3	Function templates and Class templates	3
4	Introduction to Java and its features. Defining Classes in Java, Wrapper classes, Packages and Exception handling in Java	7
5	Inheritance and Interfaces in Java. Abstract class, abstract methods, final class and final method in Java	5
6	Basic principles of Software engineering. System analysis, design, testing and debugging. Unified Modeling Language (Class Diagram, Use Case Diagram, State Diagram, Sequenced Diagram, Communication Diagram, Activity Diagram)	9
Total lectures		42

Suggested Text Book(s):

1. Lafore R., Object oriented programming in C++, Waite Group
2. Java 2: The Complete Reference, Fifth Edition -- by Herbert Schildt
3. Satzinger, Jackson, Burd, Object-Oriented Analysis & Design

Suggested Reference Book(s):

1. Stroustrap B., The C++ Programming Language, Addison Wesley
2. Bruce Eckel, Thinking in C++
3. Bruce Eckel, Thinking in Java

Other useful resource(s):

1. Link to NPTEL course contents:

    a. https://onlinecourses.nptel.ac.in/noc16_cs17/preview
    b. http://www.nptelvideos.com/java/java_video_lectures_tutorials.php
    c. https://onlinecourses.nptel.ac.in/noc17_cs25/announcements

2. Link to topics related to course:

    a. https://www.tutorialspoint.com/cplusplus/

b. http://www.cplusplus.com/doc/tutorial

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Internal Assessment	25	Entire Semester	Assignment Quizzes Attendance

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Object-Oriented Systems and Programming)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	3	3	2	2	3	3	2	3	3	3	**2.8**
CO-2	3	3	3	2	1	1	2	3	2	3	3	3	**2.4**
CO-3	3	3	2	2	2	1	2	2	2	3	3	3	**2.3**
CO-4	3	3	3	2	2	1	2	3	2	3	3	3	**2.5**
CO-5	3	3	3	3	2	1	2	3	2	1	3	3	**2.4**
CO-6	3	3	3	3	2	3	2	3	2	2	3	3	**2.7**
CO-7	3	3	2	2	2	3	3	2	2	3	3	3	**2.6**
CO-8	3	3	3	3	3	2	3	3	2	1	3	1	**2.5**
Average	**3**	**3**	**2.8**	**2.5**	**2**	**1.8**	**2.4**	**2.8**	**2**	**2.4**	**3**	**2.8**	

Python Programming with Raspberry PI Lab

COURSE CODE: 18B17CI375

COURSE CREDITS: 2

CORE/ELECTIVE: CORE

L-T-P: 0-0-4

Pre-requisite: None

Course Objectives:

1. There are two parts in this exercise manual.
2. Introduce students to the Raspberry Pi (RPi) single-board computer, and how to use its text-based commands to explore the environment of the RPi.
3. Introduce students to coding programs in Python language to display messages and images using the add-on display module (Sense HAT board) on RPi board.

Equipment and accessories required

1. Raspberry Pi 3 Model B (RPi3) board with Sense HAT add-on display module/board.
2. HDMI monitor, USB keyboard and USB mouse.
3. A USB power source to power the RPi3 board (E.g. Power Bank, Adaptor or USB port of a desktop computer).
4. Optional – A computer (desktop PC or notebook) with Ethernet port and cable for remote access of RPi3. Software (open source) to be installed on the computer – PuTTy and VNC Viewer.

Course Outcomes:

S.No.	Course outcomes	Level of Attainment
CO-1	Learn about basics of Python programming.	Familiarity
CO-2	Learn how to use Python and Shell scripts to control GPIO ports on the Pi	Assessment
CO-3	Understanding Python Programming and GPIO in Pi 3	Assessment
CO-4	Understanding interfaces on a Pi 3 (I2C, SPI, etc.)	Usage
CO-5	Storing sensor data in a dBase and plotting it	Familiarity
CO-6	MQTT Protocol	Usage

List of Experiments

S.No.	Details	Lab Hours
1	Write a Python program to get the Python version you are using. Write a Python program which accepts the radius of a circle from the user and compute the area.	**2**
2	Write a Python program to display the current date and time. Write a Python program which accepts the radius of a circle from the user and compute the area.	**2**
3	What is GPIO? Using the GPIO Pins From Python • Controlling GPIO Pins Example 1: Controlling an LED • Reading Input Example 2: Button Input Simple button input with the Raspberry Pi.	**2**
4	Binary numbers o Bitwise operations o Operator NOT o Operator AND o Operator OR o Operator XOR o Bitwise operations in python • Bit shift o Bit shift in python o Testing for bits in python • Representing binary numbers with LED on the Raspberry Pi	**2**
5	Creating Circuits on the Breadboard • The 74xx Series • Half Adders o Circuit Design o Hardware Setup	**2**

6	Full Adders • Circuit Design • Hardware Setup	**2**
7	• The MCP3008 SPI ADC chip • SPI • ADC using SPI from a Raspberry Pi	**2**
8	• How is a Servo Controlled? • Controlling a servo from the Raspberry Pi • Example of controlling a servo from the Raspberry Pi	**2**
9	○ The I2C bus ○ Digits • Controlling the 4-digit 7-segment display ○ Download the support code ○ Connections ○ Testing connections ○ Test program ○ Exercise	**2**
10	Controlling a seven-segment display from the Raspberry Pi –Part 2	**2**
11	ARM assembler in Raspberry Pi	**2**
12	Write a Python program to get an array buffer information Expected Output: Array buffer start address in memory and number of elements. (25855056, 2)	**2**
13	Write a Python program to push three items into a heap and return the smallest item from the heap. Also Pop and return the smallest item from the heap Expected Output: Items in the heap: ('V', 1) ('V', 3) ('V', 2) ---------- The smallest item in the heap: ('V', 1) ---------- Pop the smallest item in the heap: ('V', 2) ('V', 3)	**4**

14	Raspberry Pi Internet Speed Monitor	**4**
15	Capturing images using USB Camera	**4**
16	Surveillance Camera Using Android	**4**
17 18	Home theatre on Raspberry Pi	**4**
19	Adding audio port to Raspberry Pi zero	**4**
20	Face Recognition Using Raspberry Pi	**4**
21	XBee interfacing with Raspberry pi	**4**
Total Lab hours		**28**

Suggested Books/Resources:

1. Learning with Python: How to Think Like a Computer Scientist Paperback – Allen Downey , Jeffrey Elkner, 2015
2. Exploring Python, Timothy A. Budd, Mc Graw Hill Education
1. Introduction to Python for Computational Science and Engineering (A beginner's guide), Hans Fangohr
2. Learning Python, Fourth Edition, Mark Lutz, O'Reilly publication
3. How to Make Mistakes in Python Author: Mike Pirnat
4. Head First Python Paperback – by Paul Barry
5. Link to topics related to course:
6. Think Python How to Think Like a Computer Scientist
7. https://greenteapress.com/wp/think-python/
8. https://www.w3schools.com/python/
9. https://www.python.org/

EvaluationScheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Attendance	15 Marks
4	Lab Assessment	45 Marks
	Total	100 marks

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Average
CO-1	3	2	3	1	2	3	3	2	1	1	1	3	**2.1**
CO-2	3	3	3	1	2	3	3	3	2	1	1	3	**2.3**
CO-3	3	3	3	1	2	3	2	3	2	1	1	3	**2.3**
CO-4	3	3	3	3	3	3	3	2	2	1	1	3	**2.5**
CO-5	3	3	3	2	2	3	3	3	2	1	1	3	**2.4**
CO-6	3	3	3	2	3	2	3	2	2	1	1	3	**2.3**
Average	**3**	**2.8**	**3**	**1.7**	**2.3**	**2.8**	**2.8**	**2.5**	**1.8**	**1**	**1**	**3**	

Object-Oriented Systems and Programming Lab

COURSE CODE: 18B17CI371

COURSE CREDITS: 2

CORE/ELECTIVE: CORE

L-T-P: 0-0-4

Pre-requisite: None

Course Objectives:

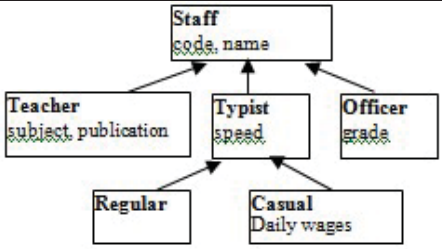
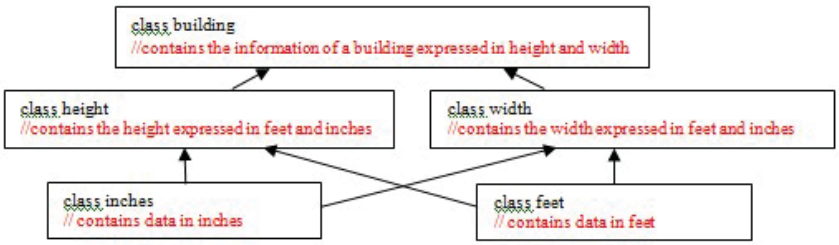
1. To use object modelling technique to analyze problem requirements, design a solution to the problem and then implement the solution in Object-Oriented Programming Language(s) or database.
2. To strengthen their problem solving ability by applying the characteristics of an object-oriented approach.
3. To strengthen ability to design and represent solutions to problems using UML notations.
4. To introduce object-oriented concepts in C++ and Java.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO1	To learn the concepts of Objects, Classes, Methods, Constructors and Destructors	Usage
CO2	To learn the designing of complex classes: Friend Functions and Static member functions, Inline functions, constant functions.	Usage
CO3	To learn Inheritance: Single Inheritance, Multiple Inheritance, Multi-level Inheritance, Hierarchical Inheritance and Hybrid Inheritance.	Usage
CO4	To learn the concept of Abstract classes and interfaces	Usage
CO5	To learn the concepts of Operator overloading and conversion function	Usage
CO6	To learn File Handling. Writing and reading data from the file, reading and writing the objects into the file.	Usage
CO7	To learn the Exception Handling: try --catch and finally block, making user-defined exceptions.	Usage
CO8	To learn the Unified Modeling Language (UML): Use Case Diagrams, State Diagrams, Sequence Diagrams, Communication Diagrams, and Activity Diagrams.	Familiarity

List of Experiments

S.No	Description	Hours
1	Create a class called Complex in C++ for performing arithmetic with complex numbers. Use double variables to represent the private data of the class. Provide public member functions for each of the following: *(Define all the member functions outside the class)* a) Enter the values of real and imaginary part. b) Addition of two Complex numbers: (The real parts are added together and the imaginary parts are added together. c) Subtraction of two Complex numbers. (The real part of the right operand is subtracted from the real part of the left operand and the imaginary part of the right operand is subtracted from the imaginary part of the left operand. d) Printing Complex numbers in the form: **a + b *i***	**2**
2	Define a class in C++ to represent a bank account. Include the following members: ***Data members:*** a) Name of the depositor b) Account number c) Type of account d) Balance amount in the account ***Member functions:*** *(Define all the member functions inside the class)* a) To assign initial values b) To deposit an amount c) To withdraw an amount after checking the balance d) To display name and balance Write a main function to create a database of 10 customers	**2**
3	a) Employees have a number, date of birth (dd-mm-yyyy), rank, and salary. When an employee is first recruited then all these are given values of 0. Upon confirmation, the actual values of these are entered for the employee. Their rank can be incremented by 1 and when this happens an employee gets an increment of 25%. Write a C++ class for Employee. b) Students are registered in a University. When students are created then they are given default values (zeroes or blanks) for roll_number, department, year, and semester of study. At registration time, the values of these attributes of student are updated with the proper values. Students can be promoted and their departments can be changed. Write a C++ class for Student.	**2**
4	Users of the computer have profile which consists of Name, Password, and Access Rights. Access rights take on values X, R, W, and ALL. It is possible to have default values for Password and Access rights which are the first three letters of the Name and ALL respectively. Users can change their password and access rights. Write a class User in C++ and create a user named Rajesh.	**2**
5	Define two classes Distance1 and Distance2 in C++. Distance1 stores distance in miles and Distance2 in kmeters & meters. Write a program that reads values of the class objects and adds one object of Distance1 with the object of Distance2 class. The display should be in the format of miles or kmeters & meters depending on the type of object (Distance1 or Distance2) being used to invoke the function. (Hint: Make use of friend function).	**2**
6	Implement a singleton class in C++. A class whose number of instances that can be instantiated is limited to one is called a singleton class. (Hint: make use of static members).	**2**

7	Imagine a publishing company that markets both books and audio-cassette version of its works. Create a class Publication in C++ that stores the title (a string) and price (type float) of a publication. From this class derive two classes: Book, which adds a page count and Tape, which adds playing time in minutes. These classes should have getdata() function to get its data from the user and the putdata() function to display its data. Write a main() program to test the book and tape classes by creating instances of them, asking the user to fill in their data with getdata() and displaying the data with putdata().	**2**
8	Implement the class hierarchy as shown in the following figure (using C++).	**2**
		
19	The database created in the experiment 8 does not include educational information of the staff. It has been decided to add this information to teacher and officers (not for typists) which will help the management in decision making with regard to training, promotion, etc. Add another data class called Education that holds two pieces of education information, namely, highest qualification in general education and highest professional qualification. The class should be inherited by the class Teacher and Officer. Modify the program of above exercise to incorporate these additions. Include overloaded constructors in all above classes.	**2**
10	Implement the class hierarchy shown in the following figure, using C++. Define appropriate member functions (including constructors and destructors) to convert feet class object into inches class object and vice versa. Also the objects of the feet and inches constructors should construct their objects using the constructors of the height and width constructor which in turn call building constructor.	**2**
		
11	Define a class Directory with members: name and phone number. Use the class object to store each set of data into a text file "phone.txt". The names contain only one word and the names and telephone numbers are separated by white spaces. Write a C++ program to read the file and output the list in two columns, such as: John 23456 Ahmed 9876	**2**

12	Write an interactive, menu-driven program that will access the file created in the experiment 11 and implement the following tasks: a) Determine the telephone number of the specified person. b) Determine the name if a telephone number is known. Update the telephone number, whenever there is a change	**2**
13	Define a class Queue in C++ that contains elements of type integer. Define two operators on Queue, '+' to insert an element in it and '–' to remove and element from it. Use the friend function approach first and then the one without friends	**2**
14	A programmer wants to manipulate arrays. Two arrays are equal if (a) they have the same dimension, (b) are of the same size, and (c) contain identical values in their corresponding elements. Comparison is done using the operator '= =' which returns true or false. Also, arrays can be copied to one another using the operator '='. Implement the foregoing using the friend function approach first and then the one without friends. Which one is preferable and why?	**2**
15	An istream class overloads the >> operator for the standard types [int, long, double, float, char]. For example, the statement cin >> x ; calls the appropriate >> operator function for the istream class defined in iostream.h and uses it to direct this input stream into the memory location represented by the variable x. Similarly, the ostream class overloads the << operator, which allows the statement cout << x to send the value of x to ostream cout for output. Overload these operators to enter the object's data members through input operator >> and display the values of these members by using the output operator <<.	**2**
16	Define a class Distance in C++ with data members: kmeter and meter. Define conversion function to convert Distance object into distance in miles (float type). Also make use of constructor to convert distance in miles (float type) into object of Distance class.	**2**
17	Define two classes Polar and Rectangle (using C++) to represent points in polar and rectangle systems. Use the conversion routines to convert from one system to the other.	**2**
18	Define a function template in C++ to sort an array of elements of int type, string type, float type and user-defined type Distance with data members: kmeter & meter.	**2**
19	Define a template class LinkedList in C++ with the following member functions: createList(), displayList(), insertElement(), and deleteElement(); In the main() function invoke above functions for the list of integer numbers, floating numbers and complex numbers.	**2**
20	Define a class Employee in Java with members: name, age and salary and methods: enterData() to enter the record of the employee through keyboard: displayData() to display the details of the employee. Define two user defined exceptions that are thrown when a) The name entered has numeric character(s). b) The age of the person is less than 18 or greater than 60.	**2**
21	Write a program in Java that demonstrates handling of exceptions in inheritance tree. For example, create a base class called "Father" and derived class called "Son" which extends the base class. In Father class, implement a constructor which takes the age and throws the exception WrongAge() where the input age <0. In Son class, implement a constructor that uses both father and son's age and throws an exception if son's age is >= father's age.	**2**

22	Define a class Person in the package MyPackage. The class has data members as: name, age, address and Methods to enter the data through keyboard and display them. Make use of overloaded constructors in the class. Now, import the above class and inherit the class Employee from this. The sub-class should have overloaded functions and also call to the base class constructors. In the main class, define a database of 5 objects and display them.	**2**
23	Define an abstract class Shape in Java, with two abstract functions: enterData() and displayArea(). Define two classes Circle and Rectangle inside a new file that inherit the class Shape and implement the abstract functions in their own way. Illustrate the concept of dynamic binding in this program.	**2**
24	Find the source code for the Vector class in the Java source code library that comes with all Java distributions. Copy this code and make a special version called intVector that holds only integers. Consider what it would take to make a special version of Vector for all the primitive types. Now consider what happens if you want to make a linked list class that works with all the primitive types. If parameterized types are ever implemented in Java, they will provide a way to do this work for you automatically.	**2**
25	Create a class MyString in Java containing a String object so that you initialize in the constructor using the constructor's argument. Add a toString() method and a method concatenate() that appends a String object to your internal string. Implement clone() in MyString. Create two static methods that each take a myString x handle as an argument and call x.concatenate("test"), but in the second method call clone() first. Test the two methods and show the difference effects.	
26	**Design the USE-CASE diagram for the following:** A description of the behavior of an automated telling machine (ATM) is given below: A user begins a transaction at the ATM by entering a bank card. If the card is readable by the machine the user is prompted to enter their personal identification number (PIN). Once this number has been entered, a menu is presented to the user containing the following options: show account balance, withdrawal with receipt and withdrawal without receipt. If the user selects one of the withdrawal options, they are prompted to enter an amount of money to withdraw; the amount entered must be a multiple of 10. The user's PIN is validated when the ATM sends the details of the transaction to the bank's remote computer. If the PIN is invalid, the user is given the option of re-entering it and the selected transaction is retired. This is repeated if the new PIN is also invalid. Once three invalid PINs have been entered, the transaction processing depends on the transaction type selected. For a show balance transaction, the balance is displayed on the screen and after they have confirmed this, the user is returned to the transaction menu. A withdrawal transaction may fail if the user has executed the amount of money that can be withdrawn from the account; in this case an error message is displayed and, after confirmation, the user is returned to the transaction menu. Otherwise, the user's card is returned and the money is issued, followed by the receipt if required. At any point where user input, other than a simple confirmation, is required, a cancel option is provided. If this is selected, the user's card is returned and their interaction with the ATM terminates.	**2**
27	**Design the Collaboration and Sequence diagram for the following:** Many word processors, graphical editors and similar tools provide cut, copy and paste operations by means of some kind of a clipboard facility. At run-time suppose that such a system consists of an instance of an Editor class linked to a number of instances of a Element class. Elements are the items manipulated by a tool, such as words or shapes. Some of the elements may have been selected by the user. The editor is also linked to an instance of a Clipboard class, which in turn	**2**

	maintains links to all the elements that have been placed in the clipboard. An element cannot simultaneously be displayed by the editor and on the clipboard. Draw a collaboration showing a configuration where there are several elements displayed by the editor and one element on the clipboard. Assume that the selected elements are identified by an additional link from the editor. Draw a sequence diagram showing what happens when the editor receives a cut message from a client. The effect of this is that all the currently selected elements are moved to the clipboard. a) Draw a sequence diagram showing what happens when the editor receives a paste message from a client. The effect of this is that all the elements on the clipboard are moved back to the editor. b) Draw a sequence diagram showing what happens when the editor receives a copy message from a client. The effect of this is that all the currently selected elements are copied to the clipboard. Assume that elements implement a clone operation, which returns a exact copy of the element. c) Draw equivalent collaboration diagrams for each of your answers.	
28	**Draw a state diagram expressing these facts about the display of windows.** A window in a window management system on a computer can be displayed in one of the three states: maximized, where it takes up the entire screen; normal, where it is displayed as a small icon. When a window is opened, it will be displayed as a normal window, unless minimize on use has been selected, in which case it will be displayed as an icon. A normal window and an icon can be maximized; a maximized window and a normal window can be minimized or reduced to an icon. Maximized windows can be restored to their normal size and icons can be restored to the size they had before they were minimized. Icons and normal windows can be moved as normal windows can also be resized. No matter how it is displayed, a window can always be closed.	**2**
Total Lab hours		**56**

Suggested Books/Resources:

1. Lafore R., Object oriented programming in C++, Waite Group
2. Java 2: The Complete Reference, Fifth Edition -- by Herbert Schildt
3. Satzinger, Jackson, Burd, Object-Oriented Analysis & Design
4. Stroustrap B., The C++ Programming Language, Addison Wesley
5. Bruce Eckel, Thinking in C++
6. Bruce Eckel, Thinking in Java

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Attendance	15 Marks
4	Lab Assessment	45 Marks
	Total	100 marks

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Average
CO1	3	3	3	3	2	2	3	3	2	3	3	3	**2.8**
CO2	3	3	3	2	1	1	2	3	2	3	3	3	**2.4**
CO3	3	3	2	2	2	1	2	2	2	3	3	3	**2.3**
CO4	3	3	3	2	2	1	2	3	2	3	3	3	**2.5**
CO5	3	3	3	3	2	1	2	3	2	1	3	3	**2.4**
C06	3	3	3	3	2	1	2	3	2	2	3	3	**2.5**
CO7	3	3	2	2	2	3	3	2	2	3	3	3	**2.6**
CO8	3	3	3	3	3	2	3	3	2	1	3	1	**2.5**
Average	**3**	**3**	**2.8**	**2.5**	**2**	**1.5**	**2.4**	**2.8**	**2**	**2.4**	**3**	**2.8**	

Programming for Problem Solving-II

COURSE CODE: 19B11CI111

COURSE CREDITS: 2

CORE/ELECTIVE: CORE

: 2-0-0

Pre-requisite: None

Course Objectives:

1. To formulate simple algorithms for arithmetic and logical problems.
2. To translate the algorithms to programs (in C language).
3. To test and execute the programs and correct syntax and logical errors.
4. To implement conditional branching, iteration and recursion.
5. To decompose a problem into functions and synthesize a complete program using divide and conquer approach.
6. To use arrays, pointers and structures to formulate algorithms and programs.
7. To apply programming to solve matrix addition and multiplication problems and searching and sorting problems.
8. To apply programming to solve simple numerical method problems, namely rot finding of function, differentiation of function and simple integration

Course outcomes:

S.NO	Course outcomes	Level of Attainment
CO-1	To formulate simple algorithms for arithmetic and logical problems.	Familiarity
CO-2	To translate the algorithms to programs (in C language).	Familiarity
CO-3	To test and execute the programs and correct syntax and logical errors.	Usage
CO-4	To implement conditional branching, iteration and recursion.	Usage
CO-5	To decompose a problem into functions and synthesize a complete program using divide and conquer approach.	Usage
CO-6	To use arrays, pointers and structures to formulate algorithms and programs.	Usage
CO-7	To apply programming to solve matrix addition and multiplication problems and searching and sorting problems.	Assessment
CO-8	To apply programming to solve simple numerical method problems, namely rot finding of function, differentiation of function and simple integration	Assessment

Course Contents:

Unit	Contents	Lectures required
1	**Introduction to Programming (4 lectures)** Introduction to components of a computer system (disks, memory, processor, where a program is stored and executed, operating system, compilers etc.) - (1 lecture). **Idea of Algorithm:** steps to solve logical and numerical problems. Representation of Algorithm: Flowchart/Pseudocode with examples. (1 lecture) From algorithms to programs; source code, variables (with data types) variables and memory locations, Syntax and Logical Errors in compilation, object and executable	4

	code- (2 lectures)	
2	**Arithmetic expressions and precedence**	**2**
3	**Loops:** Conditional Branching and Loops (6 lectures) Writing and evaluation of conditionals and consequent branching (3 lectures) Iteration and loops (3 lectures)	**6**
4	**Arrays:** Arrays (1-D, 2-D), Character arrays and Strings	**6**
5	**Basic Algorithms:** Searching, Basic Sorting Algorithms (Bubble, Insertion and Selection), Finding roots of equations, notion of order of complexity through example programs (no formal definition required.	**6**
6	**Function:** Functions (including using built in libraries), Parameter passing in functions, call by value, Passing arrays to functions: idea of call by reference **Recursion:** Recursion, as a different way of solving problems. Example programs, such as Finding Factorial, Fibonacci series, Ackerman function etc. Quick sort or Merge sort.	**5** **4**
7	**Structure:** Structures, Defining structures and Array of Structures	**4**
8	**Pointers:** Idea of pointers, Defining pointers, Use of Pointers in self-referential structures, notion of linked list (no implementation) **File handling**	**3** **2**
Total lectures		**42**

Suggested Text Book(s):

1. Byron Gottfried, Schaum's Outline of Prokli[gramming with C, McGraw-Hill
2. E. Balaguruswamy, Programming in ANSI C, Tata McGraw-Hill

Suggested Reference Book(s):

1. Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, Prentice Hall of India

Other useful resource(s):

1. Link to NPTEL course contents: https://onlinecourses.nptel.ac.in/noc18-cs10

2. Link to topics related to course:
   a. **https://www.learn-c.org/**
   b. **https://www.programiz.com/c-programming**
   c. **https://www.codechef.com/ide**

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1

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2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Programming for Problem Solving)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	2	3	2	2	3	2	3	2	2	3	3	**2.5**
CO-2	3	2	3	2	2	3	3	2	2	3	3	3	**2.6**
CO-3	2	2	2	2	2	3	3	3	2	2	3	3	**2.4**
CO-4	3	2	3	2	3	2	2	3	3	3	2	2	**2.5**
CO-5	3	2	2	2	3	2	2	2	2	3	3	3	**2.4**
CO-6	2	3	3	3	3	2	3	2	2	3	3	2	**2.6**
CO-7	2	2	2	2	2	3	3	3	2	2	3	3	**2.4**
CO-8	3	2	3	2	2	3	2	3	2	2	3	3	**2.5**
Average	**2.6**	**2.1**	**2.6**	**2.1**	**2.4**	**2.6**	**2.5**	**2.6**	**2.1**	**2.5**	**2.9**	**2.8**	

Programming for Problem Solving Lab-II

COURSE CODE: 19B17CI171

COURSE CREDITS: 2

CORE/ELECTIVE: CORE

: 0-0-4

Pre-requisite: No prior programming experience is expected however, mathematical maturity level of science or engineering undergraduate is assumed.

Course Objectives:

1. Develop problem solving ability using programming.
2. To impart adequate knowledge on the need of programming languages and problem solving techniques.
3. To develop a methodological way of problem solving
4. Analyze and construct effective algorithms
5. Employ good programming practices such as incremental development, data integrity checking and adherence to style guidelines
6. Learn a programming approach to solve problems

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Understand the Typical C Program Development Environment, compiling, debugging, Linking and executing.	Familiarity
CO-2	Introduction to C Programming using Control Statements and Repetition Statement	Usage
CO-3	Apply and practice logical formulations to solve some simple problems leading to specific applications.	Assessment and Usage
CO-4	Design effectively the required programming components that efficiently solve computing problems in real world.	Assessment & Usage

List of Experiments:

S.No	Description	Hours
1	Getting acquainted with the C program Structure and basic I/O. Getting acquainted with the various data types and arithmetic operator used in C.	2
2	Write a program to obtain the reversed number and to determine whether the original and reversed numbers are equal or not.	2
	Write a program to check whether a triangle is valid or not, when the three angles of triangle are entered through the keyboard. A triangle is valid if the sum of all three angles is equal to 180 degrees. Check a given I/P is character, number or special symbol.	
3	WAP to check a given number is Armstrong or not. Calculate factorial of a number Given number is prime or not.	2
4	Write a program to add first seven terms of the following series using any loop: 1/1! + 2/2! + 3/3! +….. Any five pattern program.	2
5	WAP to swap two numbers with function using 3rd variable or without using (call by value & reference).	2

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	Write a function to find out the roots of quadratic equation.	
6	Factorial using recursion Fibonacci series using recursion.	2
7	WAP to sort N elements of an array using bubble sort. WAP for Binary search & linear search.	2
8	Find Max, Min, 2nd Max, Standard Deviation. Reverse elements of an array.	2
9	Matrix addition, Multiplication and Transpose.	2
10	WAP to handle pointer variables and access the elements of an array using pointers. WAP to insert a string and perform operations: string length, copy, concatenation, compare, lower to upper, etc.	2
11	Write a program to find whether the string is palindrome or not using pointers Write a program to delete all vowels from sentence, assume that sentence is not more than 80 character long using pointers.	2
12	Enter the detail of 5 students using structure and print the details of all students including pointers and also sort the detail of students using DOB.	2
13	Dynamic allocation function and random function with string and integer array.	2
14	Perform operation on files: open, read, write, close etc.	2
	Total Lab hours	**28**

Suggested/Resources:

1. Yale N. Patt and Sanjay J. Patel, Introduction to Computing Systems, from bits & gates to C & beyond, 2nd Edition, 2004.
2. Deitel and Deitel, C How to Program, 7th Edition, 2013.
3. Venugopal Prasad, Mastering C, Tata McGraw Hill.
4. Complete Reference with C, Tata McGraw Hill.
5. Drmey, How to solve it by Computer, PHI.
6. Kerninghan and Ritchie, The C Programming Language.
7. http://www.acm.uiuc.edu/webmonkeys/book/c_guide/
8. http://msdn.microsoft.com/en-us/library/25db87se.aspx

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Attendance	15 Marks
4	Lab Assessment	45 Marks
	Total	100 marks

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	Average
CO1	3	3	1	1	2	2	1	1	1	2	1	2	**1.7**
CO2	3	3	2	1	3	1	1	1	1	2	1	2	**1.8**
CO3	3	3	2	2	2	3	2	1	1	2	2	2	**2.1**

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CO4	3	3	3	3	3	2	1	1	1	2	1	3	**2.2**
Average	**3**	**3**	**2**	**1.8**	**2.5**	**2**	**1.3**	**1**	**1**	**2**	**1.3**	**2.3**	

Data Structure and Algorithms

COURSE CODE: 18B11CI211

COURSE CREDIT: 4

CORE/ELECTIVE: CORE

: 3-1-0

Pre-requisites: C/C++

Course Objectives:

1. To impart the basic concepts of data structures and algorithms.
2. To understand concepts about searching and sorting techniques
3. To understand basic concepts about stacks, queues, lists, trees and graphs.
4. To enable them to write algorithms for solving problems with the help of fundamental data structures
5. Introduce students to data abstraction and fundamental data structures.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	To gain knowledge on the notions of data structure, Abstract Data Type.	Familiarity
CO-2	For a given algorithm student will able to analyze the algorithms to determine the time and computation complexity and justify the correctness.	Assessment
CO-3	For a given Search problem (Linear Search and Binary Search) student will able to implement it.	Assessment
CO-4	For a given problem of Stacks, Queues and linked list student will able to implement it and analyze the same to determine the time and computation complexity.	Assessment
CO-5	Student will able to implement Graph search and traversal algorithms and determine the time and computation complexity.	Assessment
CO-6	Student will able to write an algorithm Selection Sort, Bubble Sort, Insertion Sort, Quick Sort, Merge Sort, Heap Sort and compare their performance in term of Space and Time complexity.	Usage

Course Contents:

Unit	Contents	Lectures required

1	**Introduction:** Basic Terminologies: Elementary Data Organizations, Data Structure Operations: insertion, deletion, traversal etc.; Analysis of an Algorithm, Asymptotic Notations, Time-Space trade off. Searching: Linear Search and Binary Search Techniques and their complexity analysis.	**7**
2	**Stacks:** ADT Stack and its operations: Algorithms and their complexity analysis, Applications of Stacks: Expression Conversion and evaluation – corresponding algorithms and complexity analysis.	**5**
3	**Queues:** ADT queue, Types of Queue: Simple Queue, Circular Queue, Priority Queue; Operations on each types of Queues: Algorithms and their analysis.	**5**
4	**Linked Lists:** Singly linked lists: Representation in memory, Algorithms of several operations: Traversing, Searching, Insertion into, Deletion from linked list; Linked representation of Stack and Queue, Header nodes, Doubly linked list: operations on it and algorithmic analysis; Circular Linked Lists: all operations their algorithms and the complexity analysis.	**8**
5	**Trees:** Basic Tree Terminologies, Different types of Trees: Binary Tree, Threaded Binary Tree, Binary Search Tree, AVL Tree; Tree operations on each of the trees and their algorithms with complexity analysis. Applications of Binary Trees. B Tree, B+ Tree: definitions, algorithms and analysis.	**6**
6	**Sorting and Hashing:** Objective and properties of different sorting algorithms: Selection Sort, Bubble Sort, Insertion Sort, Quick Sort, Merge Sort, Heap Sort; Performance and Comparison among all the methods, Hashing.	**6**
7	**Graph:** Basic Terminologies and Representations, Graph search and traversal algorithms and complexity analysis.	**5**
Total lectures		**42**

Suggested Text Book(s):

1. "Fundamentals of Data Structures", Illustrated Edition by Ellis Horowitz, Sartaj Sahni, Computer Science Press

Suggested Reference Book(s):

1. "Algorithms, Data Structures, and Problem Solving with C++", Illustrated Edition by Mark Allen Weiss, Addison-Wesley Publishing Company
2. "How to Solve it by Computer", 2nd Impression by R. G. Dromey, Pearson Education.
3. "Data structures and Algorithms Made Easy" 5th edition by Narasimha Karumanchi, Career monk publications
4. "Data Structure and Algorithms in C" 2nd edition by Mark Allen Weiss (2002), Pearson Education

Other useful resource(s):

1. Link to NPTEL course contents: https://nptel.ac.in/courses/106102064/
2. Link to topics related to course:
   a. https://onlinecourses.nptel.ac.in/noc18_cs25/preview
   b. https://nptel.ac.in/courses/106103069/

Pattern Recognition

COURSE CODE: 18B1WCI638
COURSE CREDIT: 2
CORE/ELECTIVE: ELECTIVE
L-T-P: 2-0-0

Pre-requisites: Students who have just finished a first course in programming. Knowledge of writing programs in any programming language is expected. No prior experience with data structuers is required.

Course Objectives:

1. This course will introduce the fundamentals of statistical pattern recognition.
2. Generative methods such as those based on Bayes decision theory and related techniques of parameter estimation and density estimation.
3. Discussion of discriminative methods such as nearest-neighbor classification and support vector machines.
4. Applications such as information retrieval, data mining, document image analysis and recognition, computational linguistics, forensics, biometrics and bioinformatics with pattern recognition.

Course outcomes:

S.No.	Course outcomes	Level of Attainment
CO-1	Understanding of the fundamentals of statistical pattern recognition.	Familiarity
CO-2	Generative methods such as those based on Bayes decision theory and related techniques of parameter estimation and density estimation.	Assessment
CO-3	Discussion of discriminative methods such as nearest-neighbor classification and support vector machines.	Assessment
CO-4	Clustering of data and related algorithms are to be learned.	Assessment
CO-5	Clustering in large databases and related algorithms are to be learned.	Assessment
CO-6	Combinations of Classifiers are to be understood and learned with applications.	Usage
CO-7	Applications such as information retrieval, data mining, document image analysis and recognition, computational linguistics, forensics, biometrics and bioinformatics with pattern recognition.	Familiarity

Course Contents:

Unit	Contents	Lectures required
1	**Introduction –** Definitions, data sets for Pattern Recognition, Different Paradigms of Pattern Recognition, Representations of Patterns and Classes, Metric and non-metric proximity measures	6
2	**Feature extraction**, Different approaches to Feature Selection	3
3	**Nearest Neighbour Classifier** and variants, Efficient algorithms for nearest neighbor classification	3
4	**Different Approaches** to Prototype Selection, Bayes Classifier, Decision Trees, Linear Discriminant Function, Support Vector Machines	10

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5	**Clustering**, Clustering Large datasets, Combination of Classifiers	7
6	**Applications –** Document Recognition	1
Total Lectures		**32**

Suggested Text Book(s):

1. Devi V.S.; Murty, M.N. (2011) Pattern Recognition: An Introduction, Universities Press, Hyderabad.
2. R. O. Duda, P. E. Hart and D. G. Stork, Pattern Classification, Wiley, 2000.

Suggested Reference Book(s):

1. Theodoridis, Koutroumbas: Pattern Recognition, 2nd ed., Elsevier, Amsterdam, 2003
2. C.M. Bishop: Pattern Recognition and Machine Learning. Springer Verlag, Singapore, 2006.
3. C.M. Bishop: Neural Networks for Pattern Recognition. Clarendon Press, Oxford, 1996.
4. R. Schalkoff: Pattern Recognition. Statistical, Structural, and Neural Approaches. John Wiley & Sons, Inc., 1992.

Other useful resource(s):

1. Link to NPTEL course contents: http://nptel.iitm.ac.in
2. Link to topics related to course:
   i. https://www5.cs.fau.de/
   ii. https://www.tudelft.nl/ewi/over-de-faculteit/afdelingen/intelligent-systems/pattern-recognition-bioinformatics/pattern-recognition-laboratory/
   iii. https://www.dei.unipd.it/node/370

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Pattern Recognition)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	2	3	2	2	3	2	3	2	2	3	3	**2.5**
CO-2	3	2	3	2	2	3	3	2	2	3	3	3	**2.6**
CO-3	2	2	2	2	2	3	3	3	2	2	3	3	**2.4**
CO-4	3	2	3	2	3	2	2	3	3	3	2	2	**2.5**
CO-5	3	2	2	2	3	2	2	2	2	3	3	3	**2.4**
CO-6	2	3	3	3	3	2	3	2	2	3	3	2	**2.6**
CO-7	2	2	2	2	2	3	3	3	2	2	3	3	**2.4**
Average	**2.6**	**2.1**	**2.6**	**2.1**	**2.4**	**2.6**	**2.6**	**2.6**	**2.1**	**2.6**	**2.9**	**2.7**	

Pattern Recognition Lab

COURSE CODE: 18B1WCI678

COURSE CREDITS: 1

CORE/ELECTIVE: ELECTIVE

L-T-P: 0-0-2

Pre-requisites: None

Course Objectives:

1. Learning about related tools as IU Box, Labs, SPSS, PsycINFO, Web of Science
2. Learning and deployment of Statistics method
3. Learning and deployment of Pattern recognition methodology
4. Learning and deployment of Feature search
5. Learning and deployment about Computational models used in Pattern Recognition

Course Outcomes:

S.No.	Course outcomes	Level of Attainment
CO-1	Understanding about related tools as IU Box, Labs, SPSS, PsycINFO, Web of Science	Familiarity
CO-2	Explain and compare a variety of pattern classification, structural pattern recognition, and pattern classifier combination techniques.	Assessment
CO-3	Summarize, analyze, and relate research in the pattern recognition area verbally and in writing.	Assessment
CO-4	Apply performance evaluation methods for pattern recognition, and critique comparisons of techniques made in the research literature.	Assessment
CO-5	Apply pattern recognition techniques to real-world problems such as document analysis and recognition.	Assessment
CO-6	Apply Clustering in databases or large databases.	Usage
CO-7	Implement simple pattern classifiers, classifier combinations, and structural pattern recognizers.	Familiarity

List of Experiments:

S.No	Description	Hours
1	LAB: Introduction to computer resources (IU Box, Labs, SPSS, PsycINFO, Web of Science)	4
2	Statistics I. Data input/output, summary tables, charting	2
3	Statistics 2. T-tests, ANOVA, regression	2
4	Statistics 3–Factorial ANOVAs	2
5	Statistics 4. Repeated measures ANOVAs	2
6	Feature Representation	2
7	Mean and Covariance	2
8	Linear Perceptron Learning	2

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9	Generation of Random Variables	2
10	Bayesian Classification	2
11	MLE: Learning the classifier from data	2
12	Data Clustering: K-Means, MST-based	4
Total Lab hours		**28**

Suggested Books/Resources:

1. Devi V.S.; Murty, M.N. (2011) Pattern Recognition: An Introduction, Universities Press, Hyderabad.
2. R. O. Duda, P. E. Hart and D. G. Stork, Pattern Classification, Wiley, 2000.
3. https://cse20-iiith.vlabs.ac.in/
4. https://www.mathworks.com/discovery/pattern-recognition.html
5. http://nptel.iitm.ac.in
6. Link to topics related to course:
   - https://www5.cs.fau.de/
   - https://www.tudelft.nl/ewi/over-de-faculteit/afdelingen/intelligent-systems/pattern-recognition-bioinformatics/pattern-recognition-laboratory/
   - https://www.dei.unipd.it/node/370

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Attendance	15 Marks
4	Lab Assessment	45 Marks
	Total	100 marks

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Average
CO-1	3	2	3	2	2	3	2	3	2	2	3	3	**2.5**
CO-2	3	2	3	2	2	3	3	2	2	3	3	3	**2.6**
CO-3	2	2	2	2	2	3	3	3	2	2	3	3	**2.4**
CO-4	3	2	3	2	3	2	2	3	3	3	2	2	**2.5**
CO-5	3	2	2	2	3	2	2	2	2	3	3	3	**2.4**
CO-6	2	3	3	3	3	2	3	2	2	3	3	2	**2.6**
CO-7	2	2	2	2	2	3	3	3	2	2	3	3	**2.4**
Average	**2.6**	**2.1**	**2.6**	**2.1**	**2.4**	**2.6**	**2.6**	**2.6**	**2.1**	**2.6**	**2.9**	**2.7**	

Probability and Statistics

COURSE CODE: 18B11MA313

COURSE CREDITS: 4

CORE/ELECTIVE : CORE

L-T-P: 3-1-0

Pre-requisite: Working knowledge of basic calculus from Engineering Mathematics-I (18B11MA111).

Course Objectives:

1. To introduce students, the theoretical knowledge of the probability of random variables.
2. To study the fundamental concepts of descriptive and inferential techniques of statistical methodology.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Construct sample spaces of random experiments; identify and specify events, and perform set operations on events; understand the axiomatic approach of probability theory; compute probabilities by counting; evaluate conditional probability, and apply Bayes' theorem to simple situations.	Familiarity & Assessment
CO-2	Express random variables by using distribution function and density functions; calculate moments related to random variables; understand the concept of inequalities and probabilistic limits; understand the intrinsic need of (functions of) random variables for the analysis of random phenomena.	Familiarity & Assessment
CO-3	Compute probability distributions and correlation measures of bivariate random variables; obtain marginal and conditional distributions of random variables; find probabilities for outcomes of various events related to an uncertain phenomenon using appropriate probability distributions as models.	Assessment & Usage
CO-4	Compute correlation coefficient to decide the linear relationship that may exist between two variables of interest; find the equation of regression line and second degree curve, and to predict the value of one variable based on the value of the other variable.	Familiarity & Assessment
CO-5	Use central limit theorem to find probabilities for sampling distributions; conduct hypotheses tests and construct confidence- interval estimates concerning population parameters based on sample data; perform and interpret chi-square test of goodness-of-fit and test of independence.	Familiarity & Usage

Course Contents:

Unit	Contents	Lectures required
1	**Basic probability:** Random experiments; three basic approaches to probability, combinatorial probability problems; conditional probability, independence; total probability theorem, Bayes' theorem.	4
2	**Random variables:** Concept of random variables – discrete, continuous; probability distributions – probability mass function, density function and cumulative distribution function; expectation, variance and moment generating function of random variables; Chebyshev's inequality;	10

	bivariate distributions - conditional densities, distribution of sums and quotients, covariance (definition and interpretation).	
3	**Probability distributions:** Binomial, multinomial and Poisson approximation to the binomial distribution; exponential, gamma, and normal distributions.	**6**
4	**Descriptive statistics:** Measures of central tendency & dispersion: evaluation of statistical parameters (mean and variance possibly from grouped data) for binomial, Poisson and normal distributions; Measures of skewness and kurtosis; correlation and regression - rank correlation and curve fitting of straight lines, second degree parabolas and more general curves.	**10**
5	**Inferential statistics:** Introduction to sampling distribution - central limit theorem; testing of hypotheses: critical value, critical region, confidence interval, level of significance, p-value; Large and small sample tests (Z-test, t-test and F-test): single proportion, difference of proportions, single mean, difference of means, difference of standard deviations, and tests for ratio of variances and correlation coefficients; Chi-square test of goodness-of-fit and independence of attributes.	**12**
Total Lectures		**42**

Suggested Text Book(s):

1. Richard A. Johnson Irwin Miller and John E. Freund, ``Probability and Statistics for Engineers", Prentice Hall, New Delhi, 11th Edition, 2011.
2. Jay L. Devore, ``Probability and statistics for engineering and the sciences", Cengage Learning, 8th Edition, 2011.

Suggested Reference Book(s):

1. Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers and Keying E. Ye, ``Probability and statistics for engineers and scientists'', 9th Edition, Pearson, 2011.
2. Henry Stark and John W. Woods: ``Probability and random processes with applications to signal processing'', Pearson education, 3rd Edition, Asia, 2002.

Other useful resource(s):

1. Link to NPTEL course contents: https://nptel.ac.in/courses/111106112
2. Link to topics related to course:
   i. https://nptel.ac.in/courses/111105090/
   ii. https://nptel.ac.in/courses/111101004/
   iii. https://nptel.ac.in/courses/111102111/

Evaluation Scheme:

S. No.	Exam	Marks	Duration	Coverage / Scope of Examination
1.	T-1	15	1.0 Hour	Syllabus covered up to T-1
2.	T-2	25	1.5 Hours	Syllabus covered up to T-2
3.	T-3	35	2.0 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (1) - 05 Quizzes (2) - 15 Attendance - 05

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course Outcomes (Probability & Statistics)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	1	2	1	1	1	-	-	1	2	1	1.6
CO-2	3	3	1	2	2	1	1	-	-	1	2	2	1.8
CO-3	3	3	2	3	3	3	1	-	-	1	3	3	2.5
CO-4	3	3	3	3	2	3	1	-	-	2	3	3	2.7
CO-5	3	3	3	3	3	3	1	-	-	2	3	3	2.7
Average	3.0	3.0	2.0	2.6	2.4	2.2	1.0	-	-	1.4	2.6	2.4	

Plant Tissue Culture Technology

COURSE CODE

COURSE CREDITS: 3

CORE/ELECTIVE: CORE

L-T-P: 3-0-0

Pre-requisite: Biology

Course objective:

1. To provide an insight to the students on different aspects of Plant tissue culture technologies their Course Outcomes:

Sr. No.	Course outcomes	Level Attainment
CO I	To enable students for applying the knowledge about basic techniques of plant tissue culture technologies	Familiarity
CO II	To apply the learnt techniques for solving constraints linked with production of phytochemicals through cell and tissue culture technologies	Familiarity
CO III	. They will learn the strategies for analyzing, upscaling and commercialization of plant based products.	Assessment
CO IV	To enable students for exploring their avenues for entrepreneurship and social welfare	Usage
CO V	To apply To be able for developing skills for benefit generation and utilization of plant tissue culture technologies. knowledge of plant biotechnology for effective planning and strategizing of projects	

.

Course content

Sr. No	**Contents**	**Lecture hrs.**
1	Introduction of plant tissue culture and different commercial units associated	2
2	Different techniques like organ culture, somatic embryos, haploids , callus and suspension cultures	8
3	Commercially important products generated through plant cell and tissue cultures	3
4	Development of Transgenics crops (corn ,maize ,poatao, soyabean etc and concerns	4
5	Secondary metabolites, classifications and utilization for masses	5
6	Plant stem cells , their maintenance and products	4
7	Hydrophonics and Aquaphonics along with their industrial applications	2
8	Upscaling and Quantification of plant products (Phytochemicals, volatile oils and flovorants) in different bioreactor setups	3
9	Automation and robotics ,Extra terrestrial plants	3
10	Production of flavanoids and phenols through cell culture	3
11	Production of terpenoids ,alkaloids and their pathways	3
12	Role of metabolic engineering and high throughput techniques for the advancements and plant products production	3
	No of Lectures	42

Reading and reference books:

1. Plant Cell and Tissue Culture - A Tool in Biotechnology: Basics and Application (Principles and Practice) by: Karl-Hermann Neumann publisher: Springer

2. Plant cell and tissue culture for the production of food ingredients By Tong-Jen Fu, Gurmeet Singh, Wayne R. Curtis, American Chemical Society
3. Tissue Culture for Plant Propagators by R.A. de Fossard
4. Application of Plant Cell and Tissue Culture to Agriculture and Industry by D.T. Tomes, B.E. Ellis, P.M. Harney, K.J. Kasha and R.L. Peterson
5. Plant Culture Media, Volume 1,Formulations and Uses
6. by E.F. George, D.J.M. Puttock and H.J.George
7. Plant Culture Media, Volume 2,Commentary and Analysis
8. by E.F. George, D.J.M. Puttock and H.J.George
9. Micropropagation: Technology and Application by P.C. Debergh and R.H. Zimmerman Kluwer Academic Publishers

Evaluation Scheme:

Assessment	Max. marks	Duration	Course Covered
T1 Test	15	1 hr.	Syllabus covered upto T-1
T2 Test	25	1.5 hrs.	Syllabus covered upto T-2
End Term Test	35	2 hrs.	Entire Syllabus
Teacher Assessment	25	Entire Sem	Based on Assignments, quizzes etc.

Principles of Wireless Communication

COURSE CODE: 18B1WEC637

COURSE CREDITS: 2

CORE/ELECTIVE: ELECTIVE

L-T-P: 2-0-0

Pre-requisite: None

Course Objectives:

1. To understand the fundamentals of wireless communication system.
2. Analyze the design criterion of recent mobile generations.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Understand the basic blocks of wireless communication system design.	Familiarity
CO-2	Understand the concept of cellular communication.	Familiarity
CO-3	Analyze the effect of various parameters on the performance of communication system.	Assessment
CO-4	Demonstrate recent wireless communication standards.	Usage

Course Contents:

Unit	Contents	Lectures required
1	Introduction to Wireless Communication: Block diagram of communication system: source coding & channel coding, base band & band pass signal representation; 1G, 2G, 2.5G, 3G, 4G and 5G wireless standards and their Comparison; Multiplexing and multiple access techniques: FDD, TDD, FDMA,TDMA,CDMA, SDMA.	8
2	Cellular Concept: System Design Fundamentals: Introduction, Frequency Reuse, Channel Assignment Strategies, Handoff Strategies, Interference and System Capacity: co-channel interference, adjacent channel interference, Trunking and Grade of Services, Improving Coverage & Capacity in Cellular System: cell splitting, sectoring and microcell concept, Near-far Problem, Hidden node problem.	9
3	Wireless channel characteristics: Friss equation, Path loss model, Multipath propagation, Doppler shift, Parameters of wireless Multipath Channel; Small-scale and large-scale fading; Shadowing, Types of fading: flat fading, frequency selective fading, slow fading and fast fading.	7
4	3G and 4G Networks: UMTS Network, UMTS Radio Interface, UTRAN, Handover, LTE Network, 802.16 WiMAX.	6
Total lectures		30

Suggested Text Book(s):

1. T.S. Rappaport: Wireless Communication, 2nd Edition, Prentice Hall., 2002.
2. A.Goldsmith: Wireless Communication, 1st Edition , Cambridge University Press, 2005.
3. David Tse and Pramod Viswanath: Fundamentals of Wireless Communication, 1st Edition, Cambridge University Press, 2005.

Suggested Reference Book(s):

1. Jochen Schiller : Mobile Communication, 2nd edition, Pearson, 2003.
2. Martin Sauter: Beyond 3G Bringing Networks, Terminals and the Web Together, 1st Edition, John Wiley & Sons, 2008.

Other useful resource(s):

Link to NPTEL course contents: https://nptel.ac.in/courses/117102062/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Principles of Wireless Communication)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	3	2	2	2	1	2	1	2	2	3	2.18
CO-2	3	3	3	3	2	1	1	1	2	2	1	2	2
CO-3	3	3	3	2	2	2	1	2	2	2	1	3	2.17
CO-4	3	3	3	3	2	1	1	1	2	3	2	3	2.25
Average	3	3	3	2.5	2	1.5	1	1.5	1.75	2.25	1.5	2.75	

Principles of Wireless Communication Lab

COURSE CODE: 18B1WEC674

COURSE CREDITS: 1

CORE/ELECTIVE: ELECTIVE

L-T-P: 0-0-2

Pre-requisite: None

Course Objectives:

1. Understand the various techniques of practical wireless communicationsystem.
2. To get familiar with the implementation of various blocks of practical wireless system.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Understand the basics of LabView, MATLab and WiCOMM-T kit	Familiarity
CO-2	Understand basics of various analog and digital modulation techniques.	Usage
CO-3	Gain practical experience of the functioning of wireless systems.	Usage
CO-4	Analyze the performance of practical wireless communication systems.	Assessment

List of Experiments

S.No	Description	Hours
1	Introduction to various equipments of the lab.	2
2	Design, implementation and study of amplitude modulator.	2
3	Design, implementation and study of amplitude demodulator.	2
4	Design, implementation and study of amplitude shift keying modulator.	2
5	Design, implementation and study of amplitude shift keying demodulator.	2
6	Design of basic Direct Sequence- Code Division Multiple Access (DS-CDMA) system.	2
7.	Modeling and simulation of multipath fading channel.	2
8.	Bit error rate (BER) analysis of fading channel.	2
9	Analysis of Viterbi equalizer for cellular mobile communication system.	2
10	Analysis of adaptive equalization techniques.	2
11	Implementation of data compression technique for digital communication system	2
12	Mini project	2
	Total Lab hours	24

Suggested/Resources:

1. S. Haykin: Digital Communication Systems, Student Edition, Wiley,2013.
2. J.H. Reed: Software Radio: A Modern Approach to Radio Engineering, 1st Edition, Prentice Hall, 2002.

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Attendance	15 Marks
4	Lab Assessment	45 Marks
	Total	100 marks

Approved in Academic Council held on 25.10.2018

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Average
CO1	3	3	2	1	3	2	1	2	1	2	1	3	2
CO2	3	3	3	3	3	1	1	1	1	1	1	3	2.00
CO3	3	3	3	3	2	1	1	1	1	2	1	3	2.00
CO4	3	3	3	3	2	1	1	1	1	1	1	3	1.92
Average	3.00	3.00	2.75	2.50	2.50	1.25	1.00	1.25	1.00	1.50	1.00	3.00	

PhD Course

Reconfigurable Computing

COURSE CODE: 19P1WEC101

COURSE CREDITS: 3

CORE/ELECTIVE: PhD

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives

Students will gain fundamental knowledge and understanding of principles and practice in reconfigurable architecture and computing through class lectures and discussions, and reading assignments.

Course Outcomes :

S.No.	Course Outcomes	Level of Attainment
CO-1	Understand the concept of reconfigurable computing and FPGA architectures.	Familiarity
CO-2	Understand and explore the various FPGA computing platforms in terms of design tools.	Familiarity
CO-3	The student will be able to formulate the specialized arithmetic circuits and powerful techniques like pipelining and unfolding	Assessment
CO-4	Analyze the coarse-grained and fine grain configurability for performance enhancement using multi-FPGA systems.	Assessment
CO-5	To be able to create new designs and analyze advanced techniques such as fault tolerance and partial reconfiguration.	Usage
CO-6	Design, analyze and apply reconfigurable computing in various applications for optimization.	Usage

Course Contents :

S. No.	Contents	Lecture Required
1.	Introduction: Test Process and Test Economics, Functional vs Structural Testing Defects, Errors, Faults and Fault Modelling (mainly stuck at fault modelling), Fault Equivalence, Fault Dominance, Fault Collapsing and Checkpoint Theorem.	8

2.	FPGA Architectures and Algorithms of Reconfigurable Computing : General overview of computing models, Basic RC concepts, Performance, power, size, and other metrics, RC devices and architecture – fine grained and coarse grained, integration into traditional systems, FPGA computing platforms, Design tools and languages: HDLs, Synthesis, PAR, HLL and HLS, RC application development, domains and case studies, Special topics in RC: Middleware, Fault tolerance, Partial reconfiguration, device characterization.	8
3.	Implementing Applications with FPGAs : Strengths and Weaknesses of FPGAs, Time to Market, Development Time, Power Consumption, Debug and Verification, FPGAs and Microprocessors, Application Characteristics and Performance, Computational Characteristics and Performance, I/O and Performance, General Implementation Strategies for FPGA-based Systems, Configure-once, Runtime Reconfiguration, Summary of Implementation Issues, Implementing Arithmetic in FPGAs, Fixed-point Number Representation and Arithmetic, Floating-point Arithmetic, Block Floating Point, Constant Folding and Data-oriented Specialization	9
4.	Defect and Fault Tolerance : Defects and Faults, Defect Tolerance, Substitutable Resources, Yield, Defect Tolerance through Sparing, Defect Tolerance with Matching, Transient Fault Tolerance, Feedforward Correction, Rollback Error Recovery, Lifetime Defects, Detection, Repair, Configuration Upsets,	8
5.	Reconfigurable Computing and Nanoscale Architecture Trends in Lithographic Scaling, Bottom-up Technology, Nanowires, Nanowire Assembly, Crosspoints, Challenges, Nanowire Circuits, Wired-OR Diode Logic Array , Restoration, Statistical Assembly, nanoPLA Architecture, Basic Logic Block, Interconnect Architecture, Memories, Defect Tolerance, Design Mapping, Density Benefits, Nanoscale Design Alternatives, Imprint Lithography, Interfacing	9
	Total	42

Suggested Text Book (s) :

1. N. Nedjah , C. Wang, Reconfigurable and Adaptive Computing: Theory and Applications, Chapman and Hall/CRC, 1st Ed., 2018.
2. S. Hauck and A. DeHon, Reconfigurable Computing: The Theory and Practice of FPGA-Based Computation, Elsevier, 1st Ed., 2008.
3. M. B. Gokhale and P.S. Graham, Reconfigurable Computing: Accelerating Computation with Field Programmable Gate Arrays, Springer, 1st Ed., 2005.

Suggested Reference Book(s):

1. R. Cofer and B.F. Harding, Rapid System Prototyping with FPGAs: Accelerating the Design Process, Newnes, 1st Ed., 2005
2. C. Maxfield, The Design Warrior's Guide to FPGAs, Newnes, 1st Ed., 2004
3. C. Bobda, Introduction to Reconfigurable Computing: Architectures, Algorithms and Applications, Springer, 1st Ed., 2007.
4. P. Lysaght and W. Rosenstiel, New Algorithms, Architectures and Applications for Reconfigurable Computing, Springer, 1st Ed., 2005.

Other useful resource(s):

1. http://www.secs.oakland.edu/~llamocca/Fall2015_ece495.html

Software Defined Radio and Applications

COURSE CODE: 18B1WEC639

COURSE CREDITS: 2

CORE/ELECTIVE: ELECTIVE

L-T-P: 2-0-0

Pre-requisite: None

Course Objectives:

1. To know software defined radio technology and its challenges.
2. Analyze the design considerations of software defined radio.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Understand the terminology of software defined radio.	Familiarity
CO-2	Understand the need of software defined radio system in next generation communication system.	Familiarity
CO-3	Analyze the design considerations for software defined radio system.	Assessment
CO-4	Demonstrate application areas of software defined radio technology.	Usage

Course Contents:

Unit	Contents	Lectures required
1	Introduction to SDR: The need for Software Radios, What is a Software Radio, Characteristics, benefits and design principles of of a Software Radio.	6
2	Radio frequency implementation issues: Purpose of RF Front-End, Dynamic range: The principal challenge of receiver design, RF receiver front-end topologies, Enhanced flexibility of the RF chain with software radios, Transmitter architectures and their issues, Noise and distortion in the RF chain, ADC and DAC distortion.	7
3	Multirate signal processing: Introduction, Sample Rate Conversion Principles, Polyshase filters, Digital filter banks, Timing recovery in digital receivers using multirate digital filters.	4
4	Analog to digital and digital to analog conversion: Parameters of ideal data converters, Parameters of practical data converters, Techniques to improve data converter performance; Common ADC and DAC architectures	6
5	Digital hardware choices: Introduction, Key hardware elements; DSP Processors, Field programmable gate arrays, Trade-offs in using DSPs, FPGAs, and ASICs, Power management issues, Using a combination of DSPs, FPGAs, and ASICs	5
6	Case studies in software radio design.	2
Total lectures		30

Suggested Text Book(s):

1. J.H. Reed: Software Radio: A Modern Approach to Radio Engineering, 1st Edition, Prentice Hall, 2002.
2. P.B. Kenington: RF and Baseband Techniques for Software Defined Radio, 1st Edition, Norwood, MA, USA: Artech House, 2005.

Suggested Reference Book(s):

1. S. Haykin: Digital Communication Systems, Student Edition, Wiley, 2013.
2. H. Arslan: Cognitive Radio, Software Defined Radio, and Adaptive Wireless Systems, 1st Edition, Springer, 2007

Other useful resource(s):

Link to NPTEL course contents : https://nptel.ac.in/courses/108107107/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Software Defined Radio and Applications)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	2	2	2	2	1	2	1	2	2	2	2
CO-2	3	3	3	3	2	1	1	1	2	2	1	2	2
CO-3	3	3	3	2	2	2	1	2	2	2	1	3	2.17
CO-4	2	3	3	3	2	1	1	1	2	3	2	3	2.17
Average	2.75	3	2.75	2.5	2	1.5	1	1.5	1.75	2.25	1.5	2. 5	

Software Defined Radio Lab

COURSE CODE: 18B1WEC676

COURSE CREDITS: 1

CORE/ELECTIVE: ELECTIVE

L-T-P: 0-0-2

Pre-requisite: None

Course Objectives:

1. Understand the basic building blocks of software defined radio.
2. To achieve reconfigurability of communication system through software controlled parameters.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Understand the basics of MATLab and WiCOMM-T kit	Familiarity
CO-2	Attain flexibility in design and implementation of communication system.	Usage
CO-3	Gain practical experience of the functioning of next generation communication systems through SDR technology.	Usage
CO-4	Analyze the performance of reconfigurable software controlled digital communication systems.	Assessment

List of Experiments

S.No	Description	Hours
1	Introduction to WiComm-T (SDR) kit and MATLab. Interfacing of WiComm-T kit with MATLlab Basic commands of MATLab.	2
2	Demonstration of baseband digital communication system and observe effect of filter roll-off factor on eye pattern.	2
3	Implementation of BPSK Modulation and Demodulation system.	2
4	Implementation of Quadrature Phase Shift Keying Modulation and Demodulation system.	2
5	Implementation of Amplitude Shift Keying Modulation and Demodulation system.	2
6	Implementation of Quadrature Amplitude Modulation and Demodulation (QAM).	2
7	Implementation of Gaussian Minimum Shift Keying (GMSK) modulation and demodulation system.	2
8	To demonstrate GSM communication system.	2
9	To demonstrate Time Division Multiplexing and Demultiplexing.	2
10	To demonstrate Frequency Division Multiplexing and Demultiplexing.	2
11	Implementation of source coding techniques.	2
12	Implementation of channel coding and error control coding techniques.	2
	Total Lab hours	24

Suggested/Resources:

1. S. Haykin: Digital Communication Systems, Student Edition, Wiley, 2013.
2. J.H. Reed: Software Radio: A Modern Approach to Radio Engineering, 1st Edition, Prentice Hall, 2002.

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Attendance	15 Marks
4	Lab Assessment	45 Marks
	Total	100 marks

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Average
CO1	3	3	2	2	3	2	1	2	1	2	1	3	2.08
CO2	3	3	3	3	3	1	1	1	1	1	1	3	2.00
CO3	3	3	3	3	2	1	1	1	1	2	1	3	2.00
CO4	3	3	3	3	2	1	1	1	1	1	1	3	1.92
Average	3.00	3.00	2.75	2.75	2.50	1.25	1.00	1.25	1.00	1.50	1.00	3.00	

Software Engineering Practices

COURSE CODE: 19B11CI411

COURSE CREDITS: 3

CORE/ELECTIVE: CORE

L-T-P: 3-0-0

Pre-requisite: Basics of Computer Programming, Data Structures and Algorithms

Course Objectives:

1. Demonstrate the procedure of converting a valid software design into efficient code.
2. State the central themes involved in The Software Crisis.
3. Apply the concepts of Software Process and Model.
4. State the requirements for efficient Project Management.
5. Execute the needed steps in Software Design: Requirements, Specification, Architectural Design, and OOD.
6. State the steps involved in Program Verification and Validation.
7. Execute a thorough Software Test.
8. Apply the procedures for Software Quality Assurance and Cost Estimation.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Ability to apply software engineering principles and techniques.	Familiarity
CO-2	Ability to develop, maintain and evaluate large-scale software systems.	Usage
CO-3	To produce efficient, reliable, robust and cost-effective software solutions.	Usage
CO-4	Ability to perform independent research and analysis.	Usage
CO-5	To learn common lifecycle processes and requirement engineering concept.	Usage
CO-6	Ability to work as an effective member or leader of software engineering teams.	Usage
CO-7	To manage time, processes and resources effectively by prioritizing competing demands to achieve personal and team goals Identify and analyzes the common threats in each domain. .	Familiarity
CO-8	Ability to understand and meet ethical standards and legal responsibilities.	Familiarity

Course Contents:

Unit	Contents	Lectures required
Module 1	**Introduction to Software Engineering (4 lectures)** Phases in the Development of Software, Maintenance or Evolution, Software Engineering Ethics, Introduction to Software Engineering Management, Planning a Software Development Project, Controlling a Software Development Project **The Software Life Cycle:** The Waterfall Model, Agile Methods, Prototyping, Incremental Development, Rapid Application Development and DSDM, Extreme Programming, The Rational Unified Process, Intermezzo: Maintenance or Evolution, Software Product Lines, Process Modelling **Configuration Management:** Tasks and Responsibilities, Configuration Management Plan	**6**
Module 2	**People Management and Team Organization:** People Management, Coordination Mechanisms, Management Styles, Team Organization, Hierarchical Organization, Matrix Organization, Chief Programmer Team, SWAT Team, Agile Team, Open Source Software Development, General Principles for Organizing a Team **Software Quality:** A Taxonomy of Quality Attributes, Perspectives on Quality, The Quality System, Software Quality Assurance, The Capability Maturity Model (CMM),	**6**
Module 3	**Cost Estimation:** Algorithmic Models, Walston—Felix, COCOMO, Putnam, Function Point Analysis, COCOMO 2: Variations on a Theme, Guidelines for Estimating Cost, Distribution of Manpower over Time **Project Planning and Control:** A Systems View of Project Control, A Taxonomy of Software Development Projects, Risk Management, Techniques for Project Planning and Control	**6**
Module 4	**Requirements Engineering:** Requirements Elicitation, Requirements Engineering Paradigms, Requirements Elicitation Techniques, Goals and Viewpoints, Prioritizing Requirements, COTS selection, Requirements Documentation and	**6**

	Management, Requirements Specification Techniques, Verification and Validation **Modeling:** Entity--Relationship Modeling, Finite State Machines, Data Flow Diagrams (DFD), CRC Cards, The Unified Modeling Language, The Class Diagram, The State Machine Diagram, The Sequence Diagram, The Communication Diagram, The Component Diagram, The Use Case	
Module 5	**Software Architecture:** Software Architecture and the Software Life Cycle, Architecture design, Architectural views, Architectural Styles, Software Architecture Assessment **Software Design:** Design Considerations, Abstraction, Modularity, Information Hiding, Complexity, System Structure, System Structure, Classical Design Methods, Functional Decomposition, Data Flow Design (SA/SD), Design based on Data Structures, Object-Oriented Analysis and Design Methods, The Booch Method, Fusion.	**6**
Module 6	**Software Testing:** Software Testing, Test Adequacy Criteria, Fault Detection Versus Confidence Building, From Fault Detection to Fault Prevention, Testing and the Software Life Cycle, Requirements Engineering, Design, Implementation, Maintenance, Test-Driven Development (TDD), Verification and Validation Planning and Documentation, Manual Test Techniques, Walkthroughs and Inspections, Correctness Proofs, Stepwise Abstraction, Coverage-Based Test Techniques, Control-Flow Coverage, Dataflow Coverage, Coverage-Based Testing of Requirements Specifications, Fault-Based Test Techniques, Error Seeding, Mutation Testing, Error-Based Test Techniques, Comparison of Test Techniques, Comparison of Test Adequacy Criteria, Properties of Test Adequacy Criteria, Experimental Results, Different Test Stages, Estimating Software Reliability	**7**
Module 7	**Software Maintenance:** Software Maintenance, Software Maintenance, Major Causes of Maintenance Problems, Reverse Engineering and Refactoring, Reverse Engineering and Refactoring, Organizational and Managerial Issues, Organization of Maintenance Activities, Software Maintenance from a Service Perspective, Control of Maintenance Tasks, Quality Issues	**5**
Total lectures		**42**

Suggested Text Book(s):

1. Sommerville, “Introduction to Software Engineering”, 8Edition, Addison-Wesley, 2007
2. R.S. Pressman, “Software Engineering: A Practitioner's Approach”, 7Edition, McGraw Hill, 2010l.

Suggested Reference Book(s):

1. Ghezzi, Jazayeri and Mandrioli, “Fundamentals of Software Engineering”, 2Edition, Prentice-Hall, 2003
2. Peters and Pedrycz, “Software Engineering: An Engineering Approach, John Wiley, 2004
3. Len Bass, “Software Architecture in Practice”, 2Edn. Addison Wesley, 2003
4. Allamaraju, “Professional Java Server Programming”, Apress, 2004
5. Eric Gamma, “Design Patterns: Elements of Reusable OO Software”, 1994
6. A concise introduction to software Engineering, Pankaj Jalote, Springer

Other useful resource(s):

1. Link to NPTEL course contents: https://nptel.ac.in/courses/106/105/106105182/
2. Link to topics related to course:

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

CO-PO Mappings (Software Engineering Practices)													
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	
CO-1	3	2	3	2	2	3	2	3	2	2	3	3	**2.5**
CO-2	3	2	3	2	2	3	3	2	2	3	3	3	**2.6**
CO-3	2	2	2	2	2	3	3	3	2	2	3	3	**2.4**
CO-4	3	2	3	2	3	2	2	3	3	3	2	2	**2.5**
CO-5	3	2	2	2	3	2	2	2	2	3	3	3	**2.4**
CO-6	2	3	3	3	3	2	3	2	2	3	3	2	**2.6**
CO-7	2	2	2	2	2	3	3	3	2	2	3	3	**2.4**
CO-8	3	2	3	2	2	3	2	3	2	2	3	3	**2.5**
	2.6	**2.1**	**2.6**	**2.1**	**2.4**	**2.6**	**2.5**	**2.6**	**2.1**	**2.5**	**2.9**	**2.8**	**2.5**

Software Engineering Practices Lab

COURSE CODE: 19B17CI471

COURSE CREDITS: 2

CORE/ELECTIVE: CORE

L-T-P: 0-0-4

Pre-requisite: Basics of Computer Programming, Data Structures and Algorithms

Course Objectives:

1. Understand the Requirement Engineering. Identifying the Requirements from Problem Statements for a case study.
2. To understand the working of UML tools. Create and edit UML diagrams (Requirement Engineering, Design Tools,) and Reverse engineering tools
3. To understand the Object oriented analysis and Object Oriented Design (OOA/OOD). To draw UML diagrams for a case study.
4. To understand the Structured analysis/ structured design (SA/SD). To draw Data Flow Diagrams for a case study
5. To Understand the User Interface Design.
6. Analyze and Apply project management techniques for a case study

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Understand the Requirement Engineering. Identifying the Requirements from Problem Statements for a case study.	Familiarity
CO-2	To understand the working of UML tools. Create and edit UML diagrams (Requirement Engineering, Design Tools,) and Reverse engineering tools.	Assessment
CO-3	To understand the E-R Modeling. To draw UML diagrams for a case study.	Assessment
CO-4	To understand the Structured analysis/ structured design (SA/SD). To draw Data Flow Diagrams for a case study	Assessment
CO-5	To Understand the User Interface Design	Assessment
CO-6	Analyze and Apply project management techniques for a case study	Usage

List of Experiments

S.No	Description	Hours
1	Identifying the Requirements from Problem Statements (User requirements and System requirements)	2

2	Identifying the Requirements from Problem Statements (Functional requirements and Non-functional requirements)	2
3	Preparing Software Requirements Specifications (SRS)	2
4	Estimation of Project Metrics (Project Estimation Techniques)	2
5	Estimation of Project Metrics (Basic COCOMO Model, Intermediate COCOMO Model, Complete COCOMO Model)	2
6	Halstead's Complexity Metrics	2
7	Modeling UML Use Case Diagrams and Capturing Use Case Scenarios	2
8	Modeling UML class diagram & sequence diagrams	2
9	Case Study: a) Use case diagram b) Use Case Template c) activity diagrams d) sequence diagrams	2
10	UML diagram of ATM APPLICATION	2
11	UML diagram of LIBRARY MANAGEMENT SYSTEM	2
12	UML diagram of ONLINE BOOK SHOP	2
13	UML diagram of RAILWAY RESERVATION SYSTEM	2
14	UML diagram of BANKING SYSTEM	2
15	State Transition diagram	2
16	E-R Modeling from the Problem Statements (Graphical Notations for ER Diagram, Entity Generalization and Specialization, Mapping Cardinalities)	2
17	E-R Modeling of LIBRARY MANAGEMENT SYSTEM	2
18	E-R Modeling of BANKING SYSTEM	2
19	E-R Modeling of RAILWAY RESERVATION SYSTEM	2
20	Statechart Diagrams (Building Blocks of a Statechart Diagrams)	2
21	Activity Diagram Components of an Activity Diagram	2
22	DFD model (level-0, level-1)	2
23	Designing Test Suites	2
24	Project management using GanttProject	2

Mini Project	Development of Mini Project using Software Engineering Principles and Practice	8
Total Lab hours		**56**

Suggested Text Book(s):

1. Sommerville, "Introduction to Software Engineering", 8Edition, Addison-Wesley, 2007
2. R.S. Pressman, "Software Engineering: A Practitioner's Approach", 7Edition, McGraw Hill, 2010

Suggested Reference Book(s):

3. Ghezzi, Jazayeri and Mandrioli, "Fundamentals of Software Engineering", 2Edition, Prentice-Hall, 2003
4. Peters and Pedrycz, "Software Engineering: An Engineering Approach, John Wiley, 2004
5. Len Bass, "Software Architecture in Practice", 2Edn. Addison Wesley, 2003
6. Allamaraju, "Professional Java Server Programming", Apress, 2004
7. Eric Gamma, "Design Patterns: Elements of Reusable OO Software", 1994
8. A concise introduction to software Engineering, Pankaj Jalote, Springer

Other useful resource(s) for Lab:

A. Web Resources:

Software Engineering Virtual Lab **http://vlabs.iitkgp.ernet.in/se/**

B. Study Material:

List of experiments with the detailed theory required for better understanding of the experiments is posted on Student Resource. In addition additional online/downloadable resources will be useful.

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Attendance	15 Marks
4	Lab Assessment	45 Marks
	Total	100 marks

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Average
CO1	3	3	1	1	2	2	1	3	3	2	2	2	**2.1**
CO2	3	3	2	1	2	2	2	3	2	2	2	2	**2.2**
CO3	3	3	2	2	2	2	2	3	2	1	2	2	**2.2**
CO4	3	3	3	3	2	2	3	3	2	2	2	3	**2.6**
CO5	3	3	1	2	2	2	3	3	2	3	2	2	**2.3**
C06	3	1	3	2	1	2	3	3	2	3	2	1	**2.2**
Average	**3**	**2.7**	**2**	**1.8**	**1.8**	**2**	**2.3**	**3**	**2.2**	**2.2**	**2**	**2**	**2.3**

Storage Networks

COURSE CODE: 18B1WCI736

COURSE CREDIT: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisites: None

Course Objectives:

1. To learn the ability to design and implement the various aspects of storage networks.
2. To know the design model SAN, NAS, DAS, CAS, etc.
3. To learn the various technologies like SCSI, Fibre Channel, INFINIBAND, IP Stoarge etc.
4. To learn the concepts of virtualization.
5. To learn the protocols of Distributed storage networks.

Course outcomes:

S.NO	Course Outcomes	Level of Attainment
CO-1	Basics of Storage networks	Familiarity
CO-2	Design and Implement the RAID Levels.	Assessment
CO-3	Discussing algorithms related to storage networks.	Assessment
CO-4	Designing the SAN, NAS, CAS, and DAS based storage networks	Assessment
CO-5	Concepts of Data Deduplication, and File Systems.	Assessment
CO-6	Discussion of advanced topics of Distributed storage networks, protocols, and architecture.	Assessment

Course Contents:

Unit	Contents	Lectures required
1	**Intorduction to Storage Technology:** Data proliferartion, Overview of storage infrastructure components, Evolution of storage, Information Lifecycle Management concept, Basic storage management skills and activities.	6
2	**Technologies for Storage Networks:** Disk Subsystems, Overview Architecture of Intelligent Disk Subsytem, JBOD: Just A Bunch Of Disks, RAID & RAID Levels, Hot Sparing, Hard Disks and Internal I/O Channels, Caching: Acceleration of Hard Disk Access.	8
3	**I/O Techniques:** DAS, SAN, NAS, evolution, Storage Area Networks (SAN): elements & connectivity, Fibre Channel SAN & Products, IP SAN Technology & Products, IP SAN elements, standards (iSCSI, iFCP, mFCP, FCIP and iSNS), Migration from SCSI and Fibre Channel to IP storage, Network attached Storage: elements & connectivity.	10
4	**Management of Storage Network:** Requirements of Management Systems, Management Interfaces Standardized and Proprietary Mechanisms, In-	6

	band & Out- band Management.	
5	**Storage Virtualization:** The concept of storage virtualization, Storage virtualization on various levels of the storage network, Symmetric & Asymmetric Storage virtualization, Performance of SAN virtualization, Scaling storage with virtualization.	**7**
6	**Distributed Storage Networks:** Architecture, Protocols Applications, Data Deduplications, File Systems	**5**
Total lectures		**42**

Suggested Text Book(s):

1. **Storage Networks Explained"**, Ulf Troppens, Rainer Erkens, ISBN 0-470-86182-7, John Wiley& Sons.

Suggested Reference Book(s):

1. "Storage Networks: The Complete Reference", R. Spalding, ISBN:0072224762, McGraw-Hill
2. "Storage Networking Fundamentals: An Introduction to Storage Devices, Subsystems, Applications, Management, and Filing Systems", Marc Farley, ISBN: 1-58705-162-1, Cisco Press.
3. "Designing Storage Area Networks: A Practical Reference for Implementing Fibre Channel and IP SANs, Second Edition", Tom Clark, ISBN: 0-321-13650-0, Addison Wesley

Evaluation Scheme:

S.No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 hour.	Syllabus covered upto Test-1
2	T-2	25	1.5 hours	Syllabus covered upto Test-2
3	T-3	45	2 hours	Syllabus covered upto Test-3
3.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) -10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Storage networks)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	3	2	2	3	2	2	2	3	1	3	**2.4**
CO-2	3	3	3	2	3	2	3	2	2	3	1	3	**2.5**
CO-3	3	3	3	2	2	3	1	2	3	3	1	3	**2.4**
CO-4	3	3	3	2	3	3	2	2	3	3	1	3	**2.6**
CO-5	3	3	3	2	3	3	2	2	3	3	1	3	**2.6**
CO-6	3	3	3	2	3	3	2	2	1	3	1	3	**2.4**
Average	**3**	**3**	**3**	**2**	**2.7**	**2.8**	**2**	**2**	**2.3**	**3**	**1**	**3**	

Internet of Things

COURSE CODE: 18B1WCI738

COURSE CREDIT: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisites: Programming experience, preferably in MATLAB, and/or C/C++/C#/Python/Java

Course Objectives:

1. Understand the basics of IoT, The various IoT protocols and applications of various IoT technologies.
2. Be familiar with the basics of Contiki OS and standardized protocols for IPv6 Low power networking
3. Know the IEEE 802.15.4 standard and 6 LoWPAN technology
4. Understand the RPL protocol and to understand the various routing Issues in IoT
5. Be exposed to the security issues, data collection and distributed computing

Course outcomes:

S.NO	Course outcomes	Level of Attainment
CO-1	To learn IoT Architecture, Security Concerns, Security challenges and Issues, IoT five layers Security at different layers, The IoT protocols	Familiarity
CO-2	To learn about Contiki Operating System, The Hardware Platforms, IP networking, The standardized protocols for IPv6 Low power networking, The COOJA network simulator.	Familarity
CO-3	To learn The IPv6 packet format, IEEE 802.15.4 standard, IPv6 over IEEE 802.15.4, 6LoWPAN packet format, Addressing, Forwarding and Routing, Header compression, Fragmentation and Reassembly, Multicasting.	Assessment
CO-4	To study the Routing Issues in IoT, The RPL protocol and Distance Vector Routing, Storing and Non-Storing Mode of Operation, RPL control messages (ICMPv6) i.e, DIO-DAO-DIS, The objective function, Loop detection and Repair mechanisms, RPL implementation with COOJA simulator	Assessment
CO-5	To study the various development boards and their interfacing with IoT	Assessment
CO-6	To learn about Security Issues in RPL, Data collection for IoT applications, Distributed Computing in IoT	Usage

Course Contents:

Unit	Contents	Lectures required
1	**Introduction to Internet-of-Things (IoT)** Introduction to IoT, The IoT Architecture, Security Concerns, Security challenges and Issues, Security at different layers, The IoT protocols	4
2	**Contiki Operating System** The Overview of Contiki Operating System, The Hardware Platforms, IP networking, The standardized protocols for IPv6 Low power networking, The COOJA network simulator	4
3	**IEEE Standards** The IPv6 packet format, IEEE 802.15.4 standard, IPv6 over IEEE 802.15.4, 6LoWPAN packet format, Addressing, Forwarding and Routing, Header compression,	12

	Fragmentation and Reassembly, Multicasting	
4	**Routing** Routing Issues in IoT, The RPL protocol and Distance Vector Routing, Storing and Non-Storing Mode of Operation, RPL control messages (ICMPv6) i.e, DIO-DAO-DIS, The objective function, Loop detection and Repair mechanisms, RPL implementation with COOJA simulator	**12**
5	**Security Issues** Security Issues in RPL, Data collection for IoT applications, Distributed Computing in IoT	**10**
Total Lectures		**42**

Suggested Text Book(s):

i. Internet-of-Things (IoT) Systems Architectures, Algorithms, Methodologies, Dimitrios Serpanos and Marilyn Wolf, 1st edition, Springer, 2017.

ii. Building The Internet-of-Things, Maciej Kranz, Wiley, 2016.

Suggested Reference Book(s):

iii. Learning Internet-of-Things, Peter Waher, Packt Publisher, 2015.

iv. IoT in 5 days: an easy guide to Wireless Sensor Networks (WSN), IPv6 and the Internet-of-Things(IoT) , Antonio Linan Colina , Alvaro Vives, Antoine Bagula, Marco Zennaro and Ermanno Pietrose, 2015.

Other useful resource(s):

Link to NPTEL course contents: https://nptel.ac.in/courses/106105166/

Link to topics related to course:

i. https://nptel.ac.in/courses/106105166/1
ii. https://nptel.ac.in/courses/106105166/6
iii. https://nptel.ac.in/courses/106105166//3
iv. https://nptel.ac.in/courses/106105166//10
v. https://nptel.ac.in/courses/106105166//12
vi. https://nptel.ac.in/courses/106105166//15
vii. https://nptel.ac.in/courses/106105166/21
viii. https://nptel.ac.in/courses/106105166//29

Evaluation Scheme:

S.No	Exam	Marks	Duration	Coverage/Scope of Examination
1	T-1	15	1 hr.	Syllabus covered up to Test- 1.
2	T-2	25	1.5 hr.	Syllabus covered up to Test- 2.
3	T-3	35	2 hr.	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Approved in Academic Council held on 25.10.2018

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course Outcomes (Internet of Things)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	3	2	2	3	2	2	2	3	1	3	**2.4**
CO-2	3	3	3	2	3	2	3	2	2	3	1	3	**2.5**
CO-3	3	3	3	2	2	3	1	2	3	3	1	3	**2.4**
CO-4	3	3	3	2	3	3	2	2	3	3	1	3	**2.6**
CO-5	3	3	3	2	3	3	2	2	3	3	1	3	**2.6**
CO-6	3	3	3	2	3	3	2	2	1	3	1	3	**2.4**
Average	**3**	**3**	**3**	**2**	**2.7**	**2.8**	**2**	**2**	**2.3**	**3**	**1**	**3**	

Approved in Academic Council held on 25.10.2018

Mobile Computing

COURSE CODE: 18B1WCI735

COURSE CREDIT: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisites (if any): NIL

Course Objectives:

1 To learn about the concepts and principles of mobile computing;
2 To explore both theoretical and practical issues of mobile computing;
3 To develop skills of finding solutions and building software for mobile computing applications.

Course Outcome (CO)

S.NO	Course outcomes	Level of Attainment
CO-1	Overview of mobile computing: Motivations, concepts, challenges and applications of mobile computing, relationship with distributed computing, internet computing, ubiquitous/pervasive computing, mobile computing models and architectures	Familiarity
CO-2	Wireless networks: Wireless communication concepts, classification of wireless networks, cellar networks (1G, 2G, 3G, 4G), WLAN, WPAN, WMAN, satellite networks	Usage
CO-3	Mobile device plateforms: Mobile devices, mobile OS, J2ME, Windows mobile and .Net framework, BREW	Assessment
CO-4	Wireless Mobile Internet Wireless Internet architecture; Wireless gateway; Wireless application server; Synchronization server; Messaging server; Mobile Internet proxy services (transcoding, caching); Data dissemination; Disconnected operations (hording)	Assessment
CO-5	Mobile ad hoc networks: Concepts and applications; routing in mobile ad hoc networks; sensor networks, mobile peer-to-peer computing	Assessment
CO-6	Mobility management: Handoff and location management concepts; mobility management in PLMN; mobility management in mobile Internet; mobility management in mobile agent systems; adaptive location management methods	Assessment
CO-7	Location-based services: LBS applications; mobile positioning techniques; GIS; LBS architecture and protocols	Assessment
CO-8	Mobile device technology: Mobile app programming, QR Code applications, Simple software development tools for mobile apps	Usage

Course Contents:

Unit	Topic	Lectures required
1	Overview of mobile computing: Motivations, concepts, challenges and applications of mobile computing, relationship with distributed computing, internet computing, ubiquitous/pervasive computing, mobile computing	**03**

	models and architectures	
2	Wireless networks: Wireless communication concepts, classification of wireless networks, cellar networks (1G, 2G, 3G, 4G), WLAN, WPAN, WMAN, satellite networks	**09**
3	Mobile device plateforms: Mobile devices, mobile OS, J2ME, Windows mobile and .Net framework, BREW	**09**
4	Wireless Mobile Internet Wireless Internet architecture; Wireless gateway; Wireless application server; Synchronization server; Messaging server; Mobile Internet proxy services (transcoding, caching); Data dissemination; Disconnected operations (hording)	**01**
5	Mobile ad hoc networks: Concepts and applications; routing in mobile ad hoc networks; sensor networks, mobile peer-to-peer computing	**06**
6	Mobility management: Handoff and location management concepts; mobility management in PLMN; mobility management in mobile Internet; mobility management in mobile agent systems; adaptive location management methods	**04**
7	Location-based services: LBS applications; mobile positioning techniques; GIS; LBS architecture and protocols	**03**
8	Mobile device technology: Mobile app programming, QR Code applications, Simple software development tools for mobile apps	**02**
	Total lectures	**42**

Suggested Textbooks

1. R. Meier, Professional Android application development. Indianapolis, IN: Wiley, 2009.
2. Microsoft Open Technologies, Inc., Windows Phone 8 Guide for Android Application Developers.
3. Stalling, William, 2002. Wireless Communications and Networks. 2nd ed. Upper Saddle River, NJ 07458: Pearson

Suggested Reference books:

1 W. Lee and K. Mittal, Beginning Android application development. Indianapolis, Ind.: Wiley Pub., 2011.

2 A. Whitechapel and S. McKenna, Windows Phone 8 development internals. Redmond, Wash.: Microsoft Press, 2012.

3 I. Stojmenovic, Handbook of Wireless Networks and Mobile Computing. Hoboken, NJ: John Wiley & Sons, 2002.

4 Dr.S.S.Dhenakaran, A.Parvathavarthini (2013) 'An Overview of Routing Protocols in Mobile Ad-Hoc Network', International Journal of Advanced Research in Computer Science and Software Engineering, 3(2), pp. [Online]. Available at: www.ijarcsse.com.

Evaluation Scheme

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Approved in Academic Council held on 25.10.2018

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course Outcomes (Mobile Computing)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	2	3	2	2	3	3	3	3	3	1	3	**2.6**
CO-2	3	3	3	2	2	3	3	3	3	3	1	3	**2.7**
CO-3	3	3	3	3	3	3	3	3	3	3	1	3	**2.8**
CO-4	3	3	3	2	3	3	3	3	3	3	1	3	**2.8**
CO-5	3	3	3	3	2	3	3	3	2	3	1	3	**2.7**
CO-6	2	3	3	3	3	2	3	3	3	3	1	3	**2.7**
CO-7	3	2	2	3	3	3	3	3	2	2	2	2	**2.5**
CO-8	3	2	2	2	2	3	3	3	3	2	2	2	**2.4**
Average	**2.9**	**2.6**	**2.8**	**2.5**	**2.5**	**2.9**	**3**	**3**	**2.8**	**2.8**	**1.3**	**2.8**	

Cloud Computing

COURSE CODE: 18B1WCI737

COURSE CREDIT: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisites: Operating System

Course Objectives:

1. To demonstrate an understanding of cloud computing concepts and standards.
2. To understand all enabling technologies of Cloud computing.
3. To discuss issues and challenges pertaining to management of emerging cloud computing technologies and learn approaches to manage them.
4. To demonstrate the practical implementation and usage scenarios of Cloud computing.

Course outcomes:

S.No.	Course outcomes	Level of Attainment
CO-1	To learn the basic concepts, applications and terminology of cloud computing.	Familiarity
CO-2	To understand different enabling technologies for Cloud computing environment.	Assessment
CO-3	To design Cloud computing data-center for effective utilization of available resources	Usage
CO-4	To study different managers related to Cloud computing services	Assessment
CO-5	To understand dofferent case studies of Cloud computing and its advance topics	Usage

Course Contents:

Unit	Contents	Lectures required
1	**Understanding Cloud Computing:** Basic Concepts and terminology, Goals and Benefits. Risks and Challenges, Roles and boundaries, Cloud characteristics, Cluster Computing, Grid Computing, NIST Architecture, Cloud Deployment models, Cloud service models.	7
2	**Cloud Enabling Technologies:** Virtualization, Types of virtualization, Server Consolidation, virtualization management, Web Technology, Service, Oriented Architecture, Datacenter and Multi-tenancy	7
3	**Cloud Infrastructure Management:** Cloud datacenter design, Workloads and software infrastructure for a datacenter, Datacenter hardware, energy and power efficiency in a datacenter., Cloud usage monitor, Monitoring agent, Resource agent, Polling Agent	7
4	**Cloud Mechanisms:** Automated Scaling, Load Balancer, SLA Monitor, Failover System, Multi-Cloud Broker	7

5	**Fundamental Cloud Architectures:** workload distribution architecture, resource pooling architecture, dynamic scalability architecture, service load balancing architecture, cloud brusting architecture. Billing Management System Business cost metrics, cloud usage cost metrics,	7
6	Cloud service metrics., Cloud Security, Mobile cloud computing, Disaster recovery in cloud computing, Case studies	7
Total lectures		**42**

Suggested Text Book(s):

1. Cloud Computing: Concepts, Technology & Architecture, by Zaigham Mahmood, Thomas Erl, Ricardo Puttini, Prentice Hall, ISBN: 9780133387568
2. Cloud Computing Bible, by Barrie Sosinsky, Barrie Sosinsky.

Suggested Reference Book(s):

1. Cloud Computing: A Practical Approach by Anthony T. Velte, Toby J. Velte and Robert Elsenpeter; Tata McGraw – Hill Edition
2. The Datacenter as a Computer – An Introduction to the Design of Warehouse Scale Machines by Luiz Andre Barroso and Urs Holzle; Morgan and Claypool Publishers

3. Cloud Computing Explained: Implementation Handbook for Enterprises by John Rhoton
4. The Cloud at Your Service by Jothy Rosenburg and Arthur Mateos

Other useful resource(s):

1. Link to NPTEL course contents: https://onlinecourses.nptel.ac.in/noc17_cs23/preview
2. Link to topics related to course:
   i. https://www.edx.org/learn/cloud-computing
   ii. https://www.udemy.com/introduction-to-cloud-computing/

Evaluation Scheme:

S.No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Tutorials / Assignments, Quizzes, Attendance	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Cloud Computing)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	1	1	1	2	2	1	2	2	1	2	3	**1.8**
CO-2	3	2	1	2	2	2	1	2	2	1	3	2	**1.9**
CO-3	2	2	3	2	2	1	3	2	1	1	1	1	**1.8**
CO-4	2	2	3	2	2	1	3	2	1	1	1	1	**1.8**
CO-5	3	3	3	3	3	1	2	1	2	2	3	2	**2.3**
Average	**2.6**	**2**	**2.2**	**2**	**2.2**	**1.4**	**2**	**1.8**	**1.6**	**1.2**	**2**	**1.8**	

Approved in Academic Council held on 25.10.2018

Computational Techniques and Algorithms in Engineering

COURSE CODE: 18B1WCI740

COURSE CREDIT: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisites: A basic background in engineering mathematics and computational techniques is assumed. In particular, it is assumed that the student has a basic understanding of linear algebra, probability theory, on which the more advanced material in this course will be built.

Course Objectives:

1. To Solve systems of linear equations using multiple methods, including Gaussian elimination and matrix inversion. Algorithms for vector and matrix operations.
2. Positive Definite Systems, Cholesky Decomposition, LU Decomposition, Sensitivity and round-off errors.
3. To discuss Least Squares Problem, OR Decomposition.
4. To determine Eigen values and eigenvectors and solve Eigen value problems.

Course outcomes:

S.No.	Course outcomes	Level of Attainment
CO-1	Solve systems of linear equations using multiple methods, including Gaussian elimination and matrix inversion. Algorithms for vector and matrix operations.	Usage
CO-2	Positive Definite Systems, Cholesky Decomposition, LU Decomposition, Sensitivity and round-off errors	Usage
CO-3	Least Squares Problem, OR Decomposition	Usage
CO-4	SVD and QR algorithm	Usage
CO-5	,Determine Eigen values and eigenvectors and solve Eigen value problems	Assessment
CO-6	Iterative algorithms and Convergence	Assessment

Course Contents:

Unit	Contents	Lectures required
1	Matrix Vector and Matrix Matrix Multiplication Algorithms, Gaussian Elimination and Its Variants, Systems of Linear Equations, Triangular Systems, Positive Definite Systems, Cholesky Decomposition, Banded Positive Definite Systems, Sparse Positive Definite Systems, Gaussian Elimination and the LU Decomposition, Gaussian Elimination with Pivoting, Sparse Gaussian Elimination	**5**
2	Sensitivity of Linear Systems,Vector and Matrix Norms, Condition Numbers, Perturbing the Coefficient Matrix, A Posteriori Error Analysis Using the Residual, Roundoff Errors, Backward Stability, Propagation of Roundoff Errors, Backward Error Analysis of Gaussian Elimination,Scaling, Componentwise Sensitivity Analysis.	**6**
3	The Least Squares Problem, The Discrete Least Squares Problem, Orthogonal Matrices, Rotators, and Reflectors, Solution of the Least Squares Problem, The	**8**

	Gram-Schmidt Process, Geometric Approach, Updating the QR Decomposition.	
4	The Singular Value Decomposition, Some Basic Applications of Singular Values,The SVD and the Least Squares Problem, Sensitivity of the Least Squares Problem.	**4**
5	Eigenvalues and Eigenvectors, Systems of Differential Equations, The Power Method and Some Simple Extensions, Similarity Transforms, Reduction to Hessenberg and Tridiagonal Forms, The QR Algorithm, Implementation of the QR algorithm, Use of the QR Algorithm to Calculate Eigenvectors.	**12**
6	Iterative Methods for Linear Systems, The Classical Iterative Methods, Convergence of Iterative Methods, Descent Methods; Steepest Descent, Preconditioners, The Conjugate- Gradient Method, Derivation of the CG Algorithm, Convergence of the CG Algorithm, Indefinite and Nonsymmetric Problems.	**7**
Total lectures		**42**

Suggested Text Book(s):

1. Fundamentals of Matrix Computations, DAVID S. WATKINS
2. Linear Algebra Done Right, by Sheldon Axler

Suggested Reference Book(s):

1. Gilbert Strang, Linear Algebra and Its Applications, 4th Edition, Brooks Cole, 2006.
2. Gene H. Golub and Charles F. Van Loan, Matrix Computations, 3rd edition, John Hopkins University Press, 1996, ISBN 0-8018-5414-8.
3. Lloyd N. Trefethen and D. Bau III, Numerical Linear Algebra, SIAM, 1997.
4. James W. Demmel, Applied Numerical Linear Algebra, SIAM, 1997
5. Anne Greenbaum, Iterative Methods for Solving Linear Systems, SIAM, 1997.
6. Yousef Saad, Iterative Methods for Sparse Linear Systems, SIAM, 2003.
7. William L. Briggs, Van Emden Henson, Steve F. McCormick, A Multigrid Tutorial, 2nd edition, SIAM, 2000.
8. B.W. Kernighan, D.M. Ritchie, C Programming Language (2nd edition). Prentice Hall, 1988.
9. M. Banahan, D. Brady and M. Doran, The C Book, second edition, Addison Wesley, 1991.
10. C Programming, Wikibooks

Other useful resource(s):

Evaluation Scheme:

S.No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Tutorials / Assignments, Quizzes, Attendance	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Advanced Computational Techniques in Engineering)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average

Approved in Academic Council held on 25.10.2018

CO-1	3	2	3	2	2	3	2	3	2	2	3	3	83.3
CO-2	3	2	3	2	2	3	3	2	2	3	3	3	86.1
CO-3	2	2	2	2	2	3	3	3	2	2	3	3	80.6
CO-4	3	2	3	2	3	2	2	3	3	3	2	2	83.3
CO-5	3	2	2	2	3	2	2	2	2	3	3	3	80.6
CO-6	2	3	3	3	3	2	3	2	2	3	3	2	86.1
Average	88.9	72.2	88.9	72.2	83.3	83.3	83.3	83.3	72.2	88.9	94.4	88.9	

Approved in Academic Council held on 25.10.2018

Software Testing Fundamentals (Theory)

Course Name: SOFTWARE TESTING FUNDAMENTALS

Course Code: 18B1WCI633
Course Credit: L _2_ T ___ P_1_

Course Pre-requisites (if any): C/C++, Python, Eclipse, Netbeans

Course Objectives:

1. Employ correct testing terminology throughout the testing process
2. Execute specific software tests with well-defined objectives and targets.
3. Modeling techniques: UML: FSM and Statecharts, Combinatorial design; and others.
4. Apply various testing techniques, including domain, code, fault, usage and model-based.
5. Perform a complete testing process, taking into account practical considerations**.**

Detailed Course Contents:

Module	Contents	Lectures required
Module 1	**Introduction:** Error, Fault, Failure, Test automation and the importance of testing, Developer and tester as two roles, Principles of Testing, ETVX Model, Testing Maturity Model, V-Model, Software quality, Testing and debugging (preparing, Constructing, Executing, Specifying, Assessing a test plan), test Generation Strategies, Types of testing and Classifiers C1, C2, C3, C4, and C5, Static testing **Preliminaries mathematical:** Predicates and Boolean Expressions, Control Flow Graph, Program Dependence Graph, Strings languages and regular expressions,	**6**
Module 2	**Test Generation:** **a) From Domain Partitioning:** The test selection problem, Equivalence partitioning, Boundary value analysis, Category-partition method, Cause-effect graphing. **b) From Finite State Models**: Finite State machines, Conformance testing, A Fault model, Characterization Set, The w-Method, The partial W-methos. **c) From Combinatorial design**: Combinatorial designs, A combinatorial test design process, Fault model, Latin Squares, Mutually orthogonal Latin squares, Pairwise designs: binary factors, Pairwise design: multi-valued factors, Orthogonal Arrays.	**10**
Module 3	**Test Adequacy Assessment and Enhancement:**	**8**

	a) Using Control flow: Test adequacy basics, adequacy criteria based on control flow – Statement coverage, Decision coverage, condition coverage, MCC, LCSAJ, basis path coverage, b) **Using data Flow:** Definitions, C-use, p-use, Data flow graphs, du-path, dc-path, c-use coverage, p-use coverage, All-use coverage, k-dr chain coverage. **c) Using Mutation:** Mutation and Mutants, Test Assessment using mutation, Mutation operators, Founding principles of mutation testing, Equivalent mutants, Fault detection using mutation, Types of mutants.	
Module 4	**Phases of testing I:** **Regression testing:** Regression test process, Regression test selection, Selecting regression tests, test selection using execution trace, test selection using dynamic slicing	**4**
Module 5	**Phases of testing II:** Unit Testing, Integration Testing, System testing, Acceptance testing.	**4**
	TOTAL LECTURES	**32**

Suggested Text Book(s):

1. **"Foundations of Software testing," 2nd edition by Aditya P mathur, Pearson 2013**
2. **"Practical Software testing," 8th edition by Ilene Burnstein, Springer 2010**

Suggested Reference Book(s):

1. Paul C. Jorgensen, Software testing: a Craft's man approach, CRC Press
2. Srinivasan Desikan and G. Ramesh, Software Testing: Principles and Practices, Pearson Education
3. Glenford Myers, "The Art of Software Testing", John Wiley & Sons Inc., New York, 1979.
4. Cem Kaner, Jack Falk, Nguyen Quoc, "Testing Computer Software", Second Edition, Van Nostrand Reinhold, New York, 1993.
5. Boris Beizer, "Software Testing Techniques", Second Volume, Second Edition, Van Nostrand Reinhold, New York, 1990.
6. Roger S. Pressman, "Software Engineering – A Practitioner's Approach", Fifth Edition, McGraw-Hill International Edition, New Delhi, 2001.
7. Boris Beizer, "Black-Box Testing – Techniques for Functional Testing of Software and Systems", John Wiley & Sons Inc., New York, 1995.
8. K.K. Aggarwal & Yogesh Singh, "Software Engineering", New Age International Publishers, New Delhi, 2003.

Other useful resource(s):

1. Link to NPTEL course contents: https://nptel.ac.in/courses/106105150/
2. Link to topics related to course:

a. https://www.guru99.com/software-testing.html

b. **https://www.inf.ed.ac.uk/teaching/courses/st/2011-12/Resource-folder/**

Evaluation Scheme:

S.No	Examination	Marks
1	T-1	15
2	T-2	25
3	T-3	35
4	*Internal Marks	25

***Internal Marks Breakdown:**

Assignments	10 marks (3x3)
Quizzes	10 marks (4 quizzes)
Attendance/Regularity	5 marks

Course outcomes:

S.NO	**Course outcomes (Software Testing Fundamentals) (XXXXX)**	**Level of Attainment**
CO-1	Investigate the reason for bugs and analyze the principles in software testing to prevent and remove bugs.	Familiarity
CO-2	Implement various test processes for quality improvement.	Assessment
CO-3	Design test planning and manage the test process.	Assessment
CO-4	Apply the software testing techniques in commercial environment.	Assessment
CO-5	Design test adequacy assessment and enhancement criteria.	Assessment
CO-6	Use practical knowledge of a variety of ways to test software and an understanding of some of the tradeoffs between testing techniques.	Usage

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**Weightage**

CO-1	H	H	H	M	M	H	M	M	M	H	L	H	81%
CO-2	H	H	H	M	H	M	H	M	M	H	L	H	77%
CO-3	H	H	H	M	M	H	L	M	H	H	L	H	85%
CO-4	H	H	H	M	H	H	M	M	H	H	L	H	85%
CO-5	H	H	H	M	H	H	M	M	H	H	L	H	85%
CO-6	H	H	H	M	H	H	M	M	M	H	L	H	85%
Weightage	100%	100%	100%	70%	70%	80%	60%	90%	83 %	84%	70%	100%	

Software Testing Fundamentals (Lab)

Lab Course Name: Software testing Fundamentals Lab

Lab Course Code: XXXXX

Pre-requisites: Object Oriented Analysis and Design with UML, Software Engineering, Software Metrics, Basics of Mathematics.

Lab Course Objectives:

1. Have an ability to apply software testing knowledge and engineering methods.
2. Have an ability to design and conduct a software test process for a software testing project.
3. To learn how to planning a test project, design test cases and data, conduct testing operations, manage software problems and defects, generate a testing report.
4. To discuss various software testing issues and solutions in software unit test; integration, regression, and system testing.
5. To gain the techniques and skills on how to use modern software testing tools to support software testing projects.

List of Experiments:

Experiment	Details	Lab Hours

Experiment 1	Revision of Java coding using Eclipse	**2**
Experiment 2	Developing Black box test cases 1: a) Using Boundary Value Analysis	**2**
Experiment 3	Developing Black box test cases 2: a) Using Equivalent Classes	**2**
Experiment 4	Developing Black box test cases 3: a) Using Decision Tables	**2**
Experiment 5	Developing WhiteBox test cases 1: a) Performing Path testing	**2**
Experiment 6	Developing WhiteBox test cases 2: a) Performing orthogonal testing	**2**
Experiment 7	Developing WhiteBox test cases 3: a) Performing Coverage Analysis	**2**
Experiment 8	Mutation testing and developing Mutants	**2**
Experiment 9	Regression testing and Developing Regression test Cases	**2**
Experiment 10	Performing GUI testing for a designed application	**2**
Experiment 11	Performing Load testing for a designed application	**2**
Experiment 12	Getting familiar with Profiler and performing CPU, Memory analysis in real time	**4**
	TOTAL LAB Hours	**26 hrs**

Suggested Text Book(s) for Lab:

1. 1. A Practitioner's Guide to Software Test Design, Lee Copeland, 2003,
2. The Art of Software Testing, 2nd edition, Glenford Myers, et. el., 2004
3. Software Testing Techniques, 2nd edition, Boris Beizer, 1990
4. How to Break Software: A Practical Guide to Testing, James Whittaker, 2002.
5. Testing Object-Oriented Systems: Models, Patterns, and Tools, Robert V. Binder, 1999.

Suggested Reference Book(s) for Lab:

1. Software Testing and Quality Assurance: Theory and Practice Paperback – 2010

Other useful resource(s) for Lab:

Evaluation Scheme:

S.No	Exam	Marks
1	Mid Term Exam (Viva and Written Exam)	20
2	End term Exam (Viva and Written Exam)	20
3	Lab Records	15
4.	Regular Assessment (Quality and quantity of experiment performed, Learning laboratory skills, Attendance etc.)	30
5.	Attendance/Project	15

Course outcomes:

S.NO	Course outcomes (Software testing fundamentals) (XXXXX)	Level of Attainment
CO-1	Have an ability to apply software testing knowledge and engineering methods.	Familiarity
CO-2	Have an ability to design and conduct a software test process for a software testing project.	Usage
CO-3	Have an ability to identify the needs of software test automation, and define and develop a test tool to support test automation.	Assessment
CO-4	Have an ability understand and identify various software testing problems, and solve these problems by designing and selecting software test models, criteria, strategies, and methods.	Assessment
CO-5	Have an ability to use various communication methods and skills to communicate with their teammates to conduct their practice-oriented software testing projects.	Usage
CO-6	Have basic understanding and knowledge of contemporary issues in software testing, such as component-based software testing problems.	Usage
CO-7	Have an ability to use software testing methods and modern software testing tools for their testing projects.	Usage

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**Weightage**
CO-1	H	M	H	M	M	H	H	H	M	H	M	M	85.19
CO-2	H	H	H	M	H	H	H	H	M	H	M	H	83.33
CO-3	H	H	H	M	M	H	H	H	H	H	M	M	83.33
CO-4	H	H	H	H	H	H	H	M	M	H	H	H	83.33
CO-5	H	H	H	M	M	M	H	H	H	H	M	M	80.00
CO-6	H	H	H	H	H	H	H	M	M	H	H	H	83.33
CO-7	H	H	H	H	H	H	M	M	H	H	H	H	86.67
Weightage	97.44	97.44	97.44	84.62	82.05	97.44	91.00	87.18	89.74	97.44	84.62	82.05	

Software Testing Fundamentals

COURSE CODE: 18B1WCI633

COURSE CREDITS: 2

CORE/ELECTIVE: ELECTIVE

L-T-P: 2-0-0

Pre-requisites: C/C++, Python, Eclipse, Netbeans

Course Objectives:

1. Employ correct testing terminology throughout the testing process
2. Execute specific software tests with well-defined objectives and targets.
3. Modelling techniques: UML: FSM and State charts, combinatorial design; and others.
4. Apply various testing techniques, including domain, code, fault, usage and model-based.
5. Perform a complete testing process, taking into account practical considerations.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Investigate the reason for bugs and analyze the principles in software testing to prevent and remove bugs.	Familiarity
CO-2	Implement various test processes for quality improvement.	Assessment
CO-3	Design test planning and manage the test process.	Assessment
CO-4	Apply the software testing techniques in commercial environment.	Assessment
CO-5	Design test adequacy assessment and enhancement criteria.	Assessment
CO-6	Use practical knowledge of a variety of ways to test software and an understanding of some of the tradeoffs between testing techniques.	Usage

Course Contents:

Unit	Contents	Lectures required
1	**Introduction:** Error, Fault, Failure, Test automation and the importance of testing, Developer and tester as two roles, Principles of Testing, ETVX Model, Testing Maturity Model, V-Model, Software quality, Testing and debugging (preparing, Constructing, Executing, Specifying, Assessing a test plan), test Generation Strategies, Types of testing and Classifiers C1, C2, C3, C4, and C5, Static testing **Preliminaries mathematical:** Predicates and Boolean Expressions, Control Flow Graph, Program Dependence Graph, Strings languages and regular expressions,	6
2	**Test Generation:**	10
	a) **From Domain Partitioning:** The test selection problem, Equivalence partitioning, Boundary value analysis, Category- partition method, Cause-effect graphing. b) **From Finite State Models**: Finite State machines, Conformance testing, A Fault model, Characterization Set, The w-Method, The partial W-methos. c) **From Combinatorial design**: Combinatorial designs, A combinatorial test design process, Fault model, Latin Squares, Mutually orthogonal Latin squares, Pairwise designs: binary factors, Pairwise design: multi-valued factors, Orthogonal	

	Arrays.	
3	**Test Adequacy Assessment and Enhancement:** **a) Using Control flow:** Test adequacy basics, adequacy criteria based on control flow – Statement coverage, Decision coverage, condition coverage, MCC, LCSAJ, basis path coverage, **b) Using data Flow:** Definitions, C-use, p-use, Data flow graphs, du-path, dc-path, c-use coverage, p-use coverage, All-use coverage, k-dr chain coverage. **c) Using Mutation:** Mutation and Mutants, Test Assessment using mutation, Mutation operators, Founding principles of mutation testing, Equivalent mutants, Fault detection using mutation, Types of mutants.	**8**
4	**Phases of testing I:** **Regression testing:** Regression test process, Regression test selection, Selecting regression tests, test selection using execution trace, test selection using dynamic slicing	**4**
5	**Phases of testing II:** Unit Testing, Integration Testing, System testing, Acceptance testing.	**4**
Total lectures		**32**

Suggested Text Book(s):

1. "Foundations of Software testing," 2nd edition by Aditya P mathur, Pearson 2013
2. "Practical Software testing," 8th edition by Ilene Burnstein, Springer 2010

Suggested Reference Book(s):

1. Paul C. Jorgensen, Software testing: a Craft"s man approach, CRC Press
2. Srinivasan Desikan and G. Ramesh, Software Testing: Principles and Practices, Pearson Education
3. Glenford Myers, "The Art of Software Testing", John Wiley & Sons Inc., New York, 1979.
4. Cem Kaner, Jack Falk, Nguyen Quoc, "Testing Computer Software", Second Edition, Van Nostrand Reinhold, New York, 1993.
5. Boris Beizer, "Software Testing Techniques", Second Volume, Second Edition, Van Nostrand Reinhold, New York, 1990.
6. Roger S. Pressman, "Software Engineering – A Practitioner"s Approach", Fifth Edition, McGraw- Hill International Edition, New Delhi, 2001.
7. Boris Beizer, "Black-Box Testing – Techniques for Functional Testing of Software and Systems", John Wiley & Sons Inc., New York, 1995.
8. K.K. Aggarwal & Yogesh Singh, "Software Engineering", New Age International Publishers, New Delhi, 2003.

Other useful resource(s):

1. Link to NPTEL course contents: https://nptel.ac.in/courses/106105150/
2. Link to topics related to course:
   i. https://www.guru99.com/software-testing.html
   ii. https://www.inf.ed.ac.uk/teaching/courses/st/2011-12/Resource-folder/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment		Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Approved in Academic Council held on 25.10.2018

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Software Testing Fundamentals)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	3	2	2	3	2	2	2	3	1	3	**2.4**
CO-2	3	3	3	2	3	2	3	2	2	3	1	3	**2.5**
CO-3	3	3	3	2	2	3	1	2	3	3	1	3	**2.4**
CO-4	3	3	3	2	3	3	2	2	3	3	1	3	**2.6**
CO-5	3	3	3	2	3	3	2	2	3	3	1	3	**2.6**
CO-6	3	3	3	2	3	3	2	2	2	3	1	3	**2.5**
Average	**3**	**3**	**3**	**2**	**2.7**	**2.8**	**2**	**2**	**2.5**	**3**	**1**	**3**	

Science and Technology of Materials

COURSE CODE: 18B1WPH531

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE (ECE)

L-T-P: 3-1-0

Pre-requisite: None

Course Objectives:

1. To enable the students to get better understanding about materials, properties and their applications in engineering
2. To familiarize students for making proper selection of materials for different applications..
3. To enable the students to use the knowledge about materials for their projects and ultimately apply the materials knowledge in their respective professional career.
4. At the conclusion of the course, the student should have a far greater capacity to read and understand technical articles such as those seen in the IEEE Transactions on Electron Devices, IEEE Transactions on Nanotechnology, Computer-aided design, Computational Materials Science *etc*.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	To learn the fundamentals and Science of Materials.	Familiarity
CO-2	To implement the concepts and theories for analyzing the behaviour of the materials.	Familiarity
CO-3	To execute the concepts and theories in solving the problems related to material properties and their applications.	Analytical & Computational skills
CO-4	To introduce innovations in areas like Display Technology and Engineering Materials Science, etc.	Innovative Skills
CO-5	To analyze various materials for scientific and technical applications	Technical skills

Course Contents:

Unit	Contents	Lectures required
1	Introduction to Dielectric materials, Capacitance, Polarization, Types of Polarization, Polarization mechanism & Dielectric Constant, Frequency Dependence of the Dielectric Constant, Ferroelectricity, Piezoelectricity Applications of Dielectric Materials.	**10**
2	Introduction to Optoelectronic materials, Applications of Optical Phenomena Luminescence, Materials of Importance—Light-Emitting Diode Materials, photoconductivity, Lasers, Optical Fibers in Communications	**6**
3	Introduction to Thermoelectric materials, Figure of merit, Heat Capacity, Conductivity (electronic and thermal), Applications in sensors, energy harvesting etc.	**6**
4	Introduction to Magnetic materials, Concept of magnetism, Classification, dia-, para-, ferro-, antiferro- and ferri-magnetic materials, Influence of Temperature on Magnetic Behavior; Domains and Hysteresis; Magnetic Anisotropy Applications in storage devices.	**8**

5	Introduction to Superconducting materials, Superconductivity Meissner effect, Critical field, type-I and type-II superconductors; Field penetration and London equation; High temperature Superconductors and their Applications.	**4**
6	Introduction to Composite materials-Polymers & Ceramics, Various types of Polymers and their applications, Structure, Types, Properties and Applications of Ceramics, Electrical Conduction in Ceramics and Polymers. Applications.	**8**
Total lectures		**42**

Suggested Text Book(s):

1. S. O. Pillai, Solid State Physics, New age international publishers, 7th edition (2016)
2. William D. Callister and David G. Rethwisch, Materials science and engineering: an introduction, John Wiley & Sons, 8th edition (2010).
3. M.A. Wahab, Solid State Physics:Structure and Properties of Materials, Narosa, 3rd edition, (2015).

Suggested Reference Book(s):

1. Charles Kittel, Introduction to Solid State Physics. John Wiley & Sons, 8th edition 2005.
2. S. Sharma and J. Sharma, Engineering Physics, Pearson India (2018).

Other useful resource(s):

1. http://www.advancedsciencenews.com/best-of-advanced-optical-materials/
2. https://onlinecourses.nptel.ac.in/noc19_ph04/preview

EvaluationScheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes(2) -10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Materials Science)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3										3	3
CO-2	3											3	3
CO-3	1	1	1									1	1
CO-4	2	2	2	2								2	2
CO-5	3	3	3	3					3			3	3
Average Score	2.4	2.25	2	2.5					3			2.4	2.425

Solid Waste Management

COURSE CODE:18B1WCE532

COURSE CREDITS: 3

CORE/ELECTIVE: Elective

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

1. Identify the physical and chemical composition of waste.
2. Analyze the functional elements for solid waste management.
3. Understand the techniques and methods used in transformation, conservation, and recovery of materials from solid wastes.
4. Identify and design waste containment systems.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Detailed composition of Solid waste both Physical and Chemical	Familiarity
CO-2	Functional elements for solid waste management.	Assessment
CO-3	Familiarity with the techniques and method involved in solid waste management.	Assessment
CO-4	Designing of waste containment landfill system for proper treatment of MSW generated	Usage

Course Contents:

Unit	Contents	Lectures required
1	**Sources and Types:** Solid waste: Definitions, Types and Sources of waste, Waste Generation and waste generation rates. Factors affecting the generation rate, Composition characteristics and properties, Methods of sampling, Effects of improper disposal of solid wastes- Public Health and Environmental effects. Elements of solid waste management and financial aspects. Solid waste management rules, 2016, Role of NGO‘s.	8

2	**On-Site Storage and Processing:** On-Site Methods-Effect of storage, Materials used for containers- segregation of solid wastes, Public health and economic aspects of open storage, Waste Segregation and storage, Case studies under Indian scenario as well as worldwide, Source reduction of waste, reuse and recycling.	**8**
3	**Collection and Transfer:** Methods of Residential and Commercial Waste Collection, Collection Vehicles, Manpower Collection Routes, Analysis of Collection Systems, Transfer Stations – Selection of Location, Operation and Maintenance, Options Under Indian Conditions, Field Problems Solving.	**8**
4	**Off- Site Processing:** Objectives of Waste Processing – Physical Processing Techniques andEquipments; Resource Recovery from Solid Waste Composting and Bio- methanation; Thermal Processing Options – Case Studies Under Indian Conditions.	**10**
5	**Land Disposal of Solid Waste; Sanitary Landfills** – Site Selection, Design and Operation of Sanitary Landfills – Landfill Liners – Management of Leachate and Landfill Gas- Landfill Bioreactor– Dumpsite Rehabilitation	**8**
Total lectures		**42**

Suggested Text Book(s):

1. Tchobanoglous G, Theisen H and Vigil SA _Integrated Solid Waste Management, Engineering Principles and Management Issues' McGraw-Hill, 1993. Kenneth A. Berman, Jerome L. Paul: Algorithms, Cengage Learning,2002.
2. Mantell, C.L., Solid Waste Management, John Wiley, New York, 1975.
3. Peavy, H.S, Rowe, D.R., and G. Tchobanoglous, _Environmental Engineering', McGraw Hill Inc., New York, 1985.
4. Chandrappa, Ramesh, Das, D.B., Solid Waste Management: Principles and Practise, Springer, 2012.

Suggested Reference Book(s):

1. Government of India, —Manual on Municipal Solid Waste Management‖, CPHEEO, Ministry of Urban Development, New Delhi, 2016.
2. Qian X, Koerner RM and Gray DH, _Geotechnical Aspects of Landfill Design and Construction' Prentice Hall, 2002.
3. George Tchobanoglous and Frank Kreith‖Handbook of Solid waste Management‖, McGraw Hill, New York, 2002.
4. Bhide A.D. And Sundaresan, B.B. —Solid Waste Management Collection‖, Processing and Disposal, 2001.

Other useful resource(s):

1. http://www.utdallas.edu/~brikowi/Teaching/Environ_Geology/LectureNotes/WasteManagement/wasteManagement.pdf
2. http://www.csupomona.edu/~fjjanger/ce457/ce457.htm
3. http://www.cartercenter.org/resources/pdfs/health/ephti/library/lecture_notes/env_occupational_health_students/ln_solid_waste_final.pdf

Approved in Academic Council held on 25.10.2018

4. http://www.ilo.org/oshenc/part-vii/environmental-pollution-control/item/514-solid-waste-management-and-recycling
5. https://www.youtube.com/watch?v=SSIRzuE78TA
6. https://www.youtube.com/watch?v=MFmr6Yapn_A
7. https://www.youtube.com/watch?v=zchfhZZF7UY
8. https://www.youtube.com/watch?v=4552riac7VM

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered up to T-1
2	T-2	25	1.5 Hours	Syllabus covered up to T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes(2)-10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course Outcomes (Solid Waste Management)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	1	1	2	1	2	1	1	-	-	-	1	**1.33**
CO-2	2	3	2	2	2	2	2	1	-	-	-	2	**2**
CO-3	3	3	2	2	1	2	2	1	-	-	-	1	**1.88**
CO-4	3	3	3	2	2	2	2	1	-	-	-	2	**2.22**
Average	**2.5**	**2.5**	**2**	**2**	**1.5**	**2**	**1.75**	**1**	**-**	**-**	**-**	**1.5**	

Department of Civil Engineering

Approved in Academic Council held on 25.10.2018

Air and Noise Pollution and Control

COURSE CODE:18B1WCE533

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

1. Learn history of air pollution, definition of air pollution, and source and classification of air pollution.
2. Learn the effects of air pollutants on human health, vegetation and materials and major control devices to control air pollution problems.
3. Learn dispersion phenomenon of air pollutants covering diffusion and advection, meteorological components, stability of atmosphere and corresponding plume shapes.
4. Learn an overview of noise pollution including methods for prevention, control, measures and management of the pollution.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Learn the air pollution issues and characterize the elements of air pollution.	Familiarity
CO-2	Solve and design complex problems related to dispersion and air quality modeling.	Assessment
CO-3	Apply relevant techniques and methods for control and prevention of air pollution.	Assessment
CO-4	Develop an overview understanding of the strategies, regulations and policies to manage air and noise pollution.	Familiarity

Course Contents:

Unit	Contents	Lectures required
1	**Introduction:** The earth‘s atmosphere: structure and composition.	3
2	**Definition and Elements:** Air pollution: definitions: types of pollutants, sources; effect of air pollution on health, environment and materials; air pollution episodes.	5
3	**Meteorology:** Air pollution meteorology: atmospheric circulation patterns, atmospheric stability and vertical mixing, lapse rate and	6

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	temperature inversions.	
4	**Dispersion Modelling:** Atmospheric dispersions modelling: atmospheric stability classes, Gaussian model, estimation of downwind concentrations, plume rise, tall stacks, and critical wind speed.	**8**
5	**Control of Particulate Matters:** Control of particulate Matter: characteristics of particles drag force, impaction, interception and diffusion. Cyclones, Electrostatic precipitators, Fabric filter, Particulate scrubbers, spray-chambers, cyclone spray chambers, orifice and wet-impingement scrubbers, venturi and venture-jet scrubbers.	**6**
6	**Control of Gaseous Emissions:** Control of gaseous emissions: gas-liquid and gas solid equilibrium, solubility, absorption and kinetics. Gas absorption: physical and chemical absorption, isotherms, and absorption potentials.	**6**
7	**Legislation and Regulations:** Air Pollution Control Act, National Environmental Policy Act, Ambient Air Quality Standards.	**4**
8	**Noise Pollution:** Noise pollution definition, prevention and control measures, management of pollution.	**4**
Total lectures		**42**

Suggested Text Book(s):

1. H.S. Peavy, D.R. Row and G. Tchobanoglous, Environmental Engineering, Mc Graw Hill International Edition.
2. Air Pollution, M. N. Rao and H.V.N. Rao, Tata Mc Graw Hill.
3. Wark, K., & Warner, C. F. (1981). Air pollution: its origin and control.

Suggested Reference Book(s):

1. Atmospheric Pollution: History, Science, and Regulation, by Mark Z. Jacobson, Cambridge University Press, Cambridge, 2002.
2. Air Quality, by Thad Godish, 4th Edition, Lewis Publishers, 2003.
3. Atmospheric Chemistry and Physics, by John Seinfeld and Spyros Pandis, John Wiley & Sons, 1997.

Other useful resource(s):

1. Link to NPTEL course contents:https://nptel.ac.in/courses/105102089/
2. Link to topics related tocourse:https://nptel.ac.in/courses/105104099/

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Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes(2)-10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course Outcomes (Air and Noise Pollution and Control)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	1	1	1	1	1	1	2	x	x	x	2	**1.33**
CO-2	2	3	3	3	3	2	x	1	2	1	x	1	**2.1**
CO-3	2	3	3	3	3	2	2	1	2	1	x	1	**2.1**
CO-4	2	1	1	2	1	1	2	2	2	1	1	2	**1.5**
Average	**2**	**2**	**2**	**2.25**	**2**	**1.5**	**1.67**	**1.5**	**2**	**1**	**1**	**1.5**	

Traditional Bioprocesses & their upscaling

COURSE CODE: 18B1WBT832

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Microbiology, Bioprocess Engineering, Downstream Processing

Course Objectives:

Traditional bioprocess gives the lying fundamentals of the pre-historic bioprocess technologies and its scaleup studies on the industrial sectors. Moreover, these gives insights about the technological developments till the existing industrial bioprocesses. Bioprocessing of biopharmaceuticals and immobilization technology also gives an opportunity to study the recent advancements in this field. By keeping the mentioned points, the course objectives were framed as follows

1. Introduction of traditional bioprocesses and its upscaling
2. Discussion of bioprocessing of biopharmecuticals, recent advances in Immobilization technology and Fermentation technology

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Introduction to Traditional Bioprocesses and its production technologies	Familiarity
CO-2	Bioprocessing of Biopharmaceuticals	Assessment
CO-3	Recent trends in Immobilization technology and bioreactor technology	Assessment
CO-4	Upscaling studies of bioprocess products	Usage
CO-5	Scale up considerations of different bioprocess commodities	Usage

Course Contents:

Unit	Contents	Lectures required
1	**Traditional Bioprocesses: Introduction and Technology Advancemnets:** Industrial production of organic acids (Citric acid; Glutamic acid; Lactic acid; Kojic acid; Ascorbic acid) ; Industrial production of Antibiotics (Pencillins; Cephalosporins; Tetracyclins); Industrial production of Amino acids (Lysine; Threonine; Aspartate)	**14**
2	**Bioprocessing of Biopharmaceuticals:** Overview of USP and DSP aspects of Biopharmaceuticals; Upstream processing of Mab production; Downstream Processing of Mab's ; Process optimization for Mab production; Protein therapeutics	**6**
3	**Recent advances in Reactor technology:** Bioreactors for solid state fermentation ; Photobioreactors for microalgal products; Bioreactors for pharmaceuticals	**9**
4	**Advances of enzyme immobilization techniques:**Sol-gel chemistry and immobilization; Immobilization on nano-particles; Cross-linked Enzyme Aggregates; Surface analysis technology of Immobilized Enzymes	**5**

5	**Scale up considerations of different bioprocess commodities:** Bioprocess aspects of sugar alcohols; Production of flavours in food industries; Flavour production in fermented foods; Bioprocess aspects of Nutraceuticals; Probiotics, Prebiotics and Synbiotics;	**8**
Total lectures		**42**

Suggested Text Book(s):

1. Microbial Technology: Microbial processes by Henry J. Peppler, D. Perlman
2. Microbial Biotechnology by Alexander N. Glazer and Hiroshi Nikaido
3. Industrial Biotechnology by Wim Soetaert and Erick J. Vandamme
4. Immobilization of Enzymes and Cells by Jose M.Guisan
5. Biofilms in Medicine, Industry and Environmental Biotechnology by Piet Lens et al.

Suggested Reference Book(s):

1. Review / Research articles from Science Direct, Springer, Wiley and Pub Med

EvaluationScheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment, Quizzes&Attendance

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Average
CO1	3	3	3	3	1	3	1	2	1	2	1	3	2.17
CO2	3	3	3	3	2	2	1	2	1	2	-	3	2.27
CO3	3	3	3	3	2	2	1	2	1	2	-	3	2.27
CO4	3	3	3	3	1	2	2	3	2	2	2	3	2.42
CO5	3	3	3	3	1	2	3	3	3	2	2	3	2.58
Average	3.00	3.00	3.00	3.00	1.40	2.20	1.60	2.40	1.60	2.00	1.00	3.00	

Transportation Engineering

COURSE CODE:18B1WCE634

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Highway Engineering

Course Objectives:

1. To learn the fundamentals of railways, airways, water ways & other minor modes of transportation modes. .
2. To provide the students with an in-depth knowledge and understanding of the principles governing the geometric design of railways.
3. To develop an understanding of the concepts related to airport planning & design.
4. To provide fundamental concepts of harbor engineering and other modes of transportation.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	To know about the basics and scope of various components of railway and airport engineering.	Familiarity
CO-2	To be able to design the basic elements of railway and airport.	Assessment and Usage
CO-3	To enable the students to apply existing technology to the design, construction, and maintenance of railway physical facilities.	Assessment
CO-4	To learn about the aircraft characteristics, planning and components of airport.	Familiarity and Usage
CO-5	To study about the types and components of docks and harbours.	Familiarity

Course Contents:

Unit	Contents	Lectures required
1	History of railways in India, alignment and project reports, permanent way and track materials, geometric design, railway points and crossings and junction, track laying, track drainage, station yards, maintenance of track.	**14**
2	Development of air transport in India ,airport planning, airport design standards, terminal lay out & classification, Design of airport pavements, drainage, marking &lighting, heliports, air traffic control,	**13**

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	air cargo, accidents in the air, maintenance of air ports .	
3	Historical development in India , tides, winds & waves, docks, harbours, break waters, jetties, landing stages & wharves, dry docks, transit sheds, cargo handling, , inland water transport. Maintenance.	**9**
4	Pipelines, elevators, belt conveyors, aerial rope ways, & under sea transportation.	**6**
Total lectures		**42**

Suggested Text Book(s):

1. Railway engineering, Subhash.C.Saxena & Satyapal Arora, Dhanpat rai &sons,
2. Railway, Airport and Harbour Engineering, K.P. Subramanian, Scitech Publication
3. Railways, bridges &tunnels, Vazirani. V.N, Chandola.S.P, Khanna publications, New Delhi

Suggested Reference Book(s):

1. Airport planning &design, Khanna .S.K, Neem chand publications, Roorkee,
2. Docks &harbors, Levison Francis, Clarendon press,

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes(2)-10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course Outcomes (Transportation Engineering)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	3	3	2	2	1	2	3	2	2	3	**2.42**
CO-2	3	3	3	3	2	2	1	2	3	2	2	2	**2.33**
CO-3	3	3	3	2	2	2	1	2	2	2	2	3	**2.25**
CO-4	3	3	3	2	2	1	1	2	3	3	2	2	**2.25**
CO-5	3	2	3	3	3	1	1	3	3	3	3	2	**2.5**
Average	**3**	**2.8**	**3**	**2.6**	**2.2**	**1.6**	**1**	**2.2**	**2.8**	**2.4**	**2.2**	**2.2**	

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Understanding India: Literary Reflections

COURSE CODE: 18BIWHS636
COURSE CREDITS: 3
CORE/ELECTIVE: Elective
L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

1. To understand migration.
2. To recognize the impact of displacement on individuals.
3. To explore social, economic, cultural and geographical contexts and its relevance for a holistic living.
4. To look for roots and connections in literature with focus on environment and peace in society.
5. To access the impact of gender on migration.
6. To define identity and what it means in the modern context.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Analyze the reason and impact of migration and displacement	Familiarity
CO-2	Explore and understand the socio-cultural and geographical contexts for a holistic living	Assessment
CO-3	Demonstrate familiarity with gender issues	Assessment
CO-4	Understanding the links and connections in construction of identity.	Usage
CO-5	Apprise the students with socio-cultural concepts and historical events like Dalit literature, Bhakti Radicals and Partition literature respectively	Familiarity

Course Contents:

Unit	Contents	Lectures required
1	**Modern Literature** Cross-cultural Reflections in Vinay Rai's "A Rainbow of Contradictions" from *Think India*	3
2	**From other Margins** **(Regional environment/ecology, traditions, folklores)** Mamang Dai's "Sorrow of Women" and "An Obscure Place" Sanjoy Hazarika's "There are No Shangri-Las Left"	8
3	**Indian Culture, tradition and societal norms** Rajiv Malhotra's "Indian Comfort with Chaos" and "Western Joker and Indian Clown" from *Being Different: An Indian Challenge to Western Universalism*	8
4	**Views on Education, Indian ethos, identity and rural development** S. Radhakrishnan's "The Adaptive Culture" and "Of One Mind" from *The Adaptive Indian: Identity and Ethos*	4
5	**Partition Literature: Migration and identity** Jhumpa Lahiri's "The Triangle", "The Second Exile" and "The Wall" from *In Other Words* Ismat Chugtai's *Roots* rature: Migration and Identity	8
6	**Bhakti Radicals and Dalit Literature: Human Rights in India against caste system** The Bhakti Radicals and Untouchability by Gail Omvedt from *Speaking Truth to Power: Religion, Caste and the Subaltern Question in India* Introduction to Dalit Movement; *Karukku* by Bama	3
Total lectures		**42**

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Suggested Text Book(s):

1. Malhotra, Rajiv. *Being Different: An Indian Challenge to Western Universalism*. Harper Collins: Noida, 2013
2. Radhakrishnan, S. *The Adaptive Indian: Identity and Ethos.* Orient Paperbacks: New Delhi, 2013
3. Lahiri, Jhumpa. *In Other Words.* Penguin: New Delhi, 2017
4. Bhagavan, Manu and Anne Feldhaus.Eds. *Speaking Truth to Power: Religion, Caste and the Subaltern Question in India.* OUP: New Delhi, 2008.
5. Asaduddin, M. *Ismat Chugtai: Lifting the Viel.* Modern Classics. Penguin: New Delhi, 2009

Other useful resource(s):

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment - 6 Group Discussions- 6 Presentations – 8 Class Assessment-5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Understanding India: Literary Reflections)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	1	2	2	2	2	1	3	3	2	2	2	3	2.0
CO-2	1	3	3	3	3	1	1	3	2	2	1	3	2.1
CO-3	1	2	2	2	3	2	2	3	2	2	1	3	2.0
CO-4	1	3	3	3	2	3	3	3	2	3	2	3	2.5
CO-5	1	3	3	3	2	3	3	3	2	3	1	3	2.5
Average	1	2.6	2.6	2.6	2.4	2	2.4	3	2	2.4	1.4	3	

Wireless and Data Communication

COURSE CODE: 18B11EC611

COURSE CREDITS: 3

CORE/ELECTIVE: CORE

: 3-0-0

Pre-requisite: None

Course Objectives:

1. To understand the fundamentals of wireless and data communication networks.
2. To allow the students to learn network architecture and protocols of trending wireless networks.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Understand the basics of wireless communication system and various wireless standards.	Familiarity
CO-2	Have the basic knowledge of computer networks and its applications in communication engineering.	Familiarity
CO-3	Understand the behavior of wireless channel.	Usage
CO-4	Have the knowledge of data sharing and their protocols.	Usage
CO-5	Brief the recent protocols and standards of various communication networks.	Assessment
CO-6	Get familiar with the recent wireless communication systems.	Assessment

Course Contents:

Unit	Contents	Lectures required
1	Review of Wireless Communication: Introduction to Wireless Communication, Basic building blocks of wireless system: source coding & channel coding, base band & band pass signal representation; 1G, 2G, 2.5G, 3G, 4G and 5G wireless standards and their Comparison; Multiple Access techniques: TDMA, FDMA, CDMA, OFDMA.	6
2	Wireless Channel: Linear Time Varying System; Path loss model; Multipath Propagation; Doppler Shift; Parameters of Wireless Multipath Channel; Small-scale and large-scale fading; Shadowing, Types of Fading: flat fading, frequency selective fading, slow fading and fast fading; Capacity of wireless channel: Capacity of AWGN, Flat Fading and Frequency Selective Channels.	10
3	Data Communication: OSI vs TCP/IP model; Wired vs Wireless; Circuit switching/ Packet switching; Flow control and error control; CRC; Connection oriented/connection less transmission; Bit stuffing.	7
4	MAC, Network and transport layer protocols: Dynamic multiple access methods: ALOHA, slotted ALOHA, CSMA/CD etc; Routing algorithms: DSDV, LSR, AODV; Broadcasting methods: flooding, spanning tree, multicasting; UDP, TCP, IP, IPv4, IPv6, QoS.	8
5	Wireless Networks: Introduction to WiFi; 802.11, 802.11a and 802.11 b Wireless LANs; Frame structure; Modes of operation; Data rates; Power management; Handoff strategies, Medium access control etc. Bluetooth networks: Piconet, scatternet, frame structure, data rates; synchronous and asynchronous services, power saving etc	8
6	Recent Trends: Introduction to WiMAX and ZigBee Networks; Software Defined Radio; UWB Radio; Wireless Adhoc Network and Mobile Portability; Security issues and challenges in a Wireless network.	3

Total lectures	42

Suggested Text Book(s):

1. T.S. Rappaport, "Wireless Communication", 2nd Edition, Prentice Hall., 2010.
2. A. Tanenbaum, "Computer Networks", 5th Edition, Prentice Hall, 2011.
3. Bahrouz Forouzan, "Data communication & Networking," 5th Edition, McGraw Hill, 2017.

Suggested Reference Book(s):

1. William Stallings, "Data and Computer Communications," 10th Edition, Pearson.,2013.

Other useful resource(s):

Link to NPTEL course contents:

1. https://nptel.ac.in/courses/117102062/36
2. https://nptel.ac.in/courses/106105082/31

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Wireless and Data Communication)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	2	1	3	1	1	1	1	1	2	1	2	1.58
CO-2	3	3	1	3	2	1	1	3	1	2	1	2	1.92
CO-3	3	3	2	3	2	1	2	3	1	2	1	2	2
CO-4	3	3	3	3	2	1	2	3	1	2	1	2	2.17
CO-5	3	3	3	3	3	1	2	3	2	2	1	2	2.33
CO-6	3	3	3	3	3	1	3	3	3	2	3	2	2.67
Average	3	3	2.17	3	2.17	1	1.83	2.67	1.5	2	1.33	2	

Workshop Practices

COURSE CODE:18B17GE171

COURSE CREDITS: 1.5

CORE/ELECTIVE: CORE

: 0-0-3

Pre-requisite: Concrete Technology

Course Objectives:

1. To learn the basics of different workshop practices by understanding and implementing used in different shops of workshop.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO1	Study of various carpentry processes and its applications in carpentry	Familiarity
CO2	Study and practice the use of various carpentry tools for different carpentry processes	Familiarity
CO3	Study and manufacturing of different wood working joints	Assessment
CO4	Study the principles, classification and application of different welding processes	Usage
CO5	Study and Manufacturing of various welding joints using electric arc welding and gas welding	Usage

List of Experiments

S.NO.	Subtitle	Topics
1.	Carpentry	To Study the carpentry processes
		To study and identify carpentry tools
		To prepare a T-Lap Joint
		To prepare Motise-tenon joint
		To prepare corner joint
2.	Welding	To study the different welding processes with mechanism
		To prepare lap welding joint
		To prepare butt welding joint
3.	Sheet Metal work	To cut and prepare V joint from metal using hexablade
4.	Turning	To study the lathe machine and its operation with one turning job

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Suggested/Resources:

1. Workshop Practices by S.K. Hajra and Chaudhary

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Attendance	15 Marks
4	Lab Assessment	45 Marks
	Total	100 marks

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Average
CO1	3	3	3	3	2	2	1	1	1	1	1	1	**1.83**
CO2	3	3	3	3	3	1	1	1	1	1	1	3	**2.00**
CO3	3	3	2	3	2	3	2	1	1	1	2	1	**2.00**
CO4	3	3	3	2	3	2	1	1	1	1	1	1	**1.83**
CO5	2	2	3	3	3	3	1	1	1	1	1	1	**1.83**
Average	**2.80**	**2.80**	**2.80**	**2.80**	**2.60**	**2.20**	**1.20**	**1.00**	**1.00**	**1.00**	**1.20**	**1.40**	

Web Technology Lab

COURSE CODE: 18B17CI474

COURSE CREDITS: 2

CORE/ELECTIVE: CORE

L-T-P: 0-0-4

Pre-requisite: None

Course Objectives:

1. To develop the ability to design and implement web enabled applications.
2. The student shall acquire the skill to design and develop web based applications with high usability, scalability and efficiency.
3. They shall be exposed to various technologies required to design web sites
4. They shall acquire the skill to choose the technology to use based on the requirements and functionality of the web site

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO1	Basic PHP Concepts, PHP Operators, PHP Function, PHP Variables and Super globals.	Familiarity
CO2	Conditional Statements, Looping Statements, Array, Cookies, PHP Form, PHP Session, File Upload, File Handling, User login and Registration.	Usage
CO3	Database Connectivity, MySQL, MySQL connect, create DB/Table, Instructions such as select, where, order By, update and delete etc., encryption methods.	Familiarity
CO4	Create and save an XML document at the server, which contains 10users information. Write a program which takes User Id as input and returns the user details by taking the user information from the XML document.	Assessment
CO5	To get familiar with JavaScript, working with operators, Conditional Statements, looping statements, Alert Box, Confirm Box and Prompt Box, Functions, Array, event handler, regular expressions and modifiers, Cookie and form validations.	Assessment
CO6	Validate the registration, user login, user profile and payment by credit card pages using JavaScript.	Usage

List of Experiments

S.No	Description	Hours
1	Basic PHP Concepts, PHP Operators, PHP Function, PHP Variables and Super globals,	6
2	Conditional Statements, Looping Statements, Array, Cookies, PHP Form, PHP Session, File Upload, File Handling, User login and Registration	6
3	Database Connectivity, MySQL, MySQL connect, create DB/Table, Instructions such as select, where, order By, update and delete etc., encryption methods.	6
4	Project-To develops and implement, and demonstrate Database Driven Websites through a project that meet stated specifications.	4
5	Create and save an XML document at the server, which contains 10users information. Write a program which takes User Id as input and returns the user details by taking the user information from the XML document.	6
6	To get familiar with JavaScript, working with operators, Conditional Statements,	6

	looping statements, Alert Box, Confirm Box and Prompt Box, Functions, Array, event handler, regular expressions and modifiers, Cookie and form validations.	
7	Validate the registration, user login, user profile and payment by credit card pages using JavaScript.	4
8	Bean Assignments a. Create a JavaBeans which gives the exchange value of INR (Indian Rupees) into equivalent American/Canadian/Australian Dollar value. b. Create a simple Bean with a label which is the count of number of clicks. Then create a Bean info class such that only the count properly is visible in the property Window. c. Create two Beans – a) Keypad b) Display pad. After that integrate the two Beans to make it work as a calculator. d. Create two Beans Traffic Light (implemented as a label with only three background colors-red, green, yellow) and Automobile (Implemented as a Text Box which states its state/movement). The state of the Automobile should depend on the following Light Transition table	8
9	XML Concepts, XML Elements and Attributes, DTD and Schema, XML with CSS.	4
10	Install TOMCAT web server. Convert the static web pages of assignments 2 into dynamic web pages using servlets and cookies. Hint: User‟s information (user id, password, credit card number) would be stored in web. Xml. Each user should have a separate shopping cart	6
Total Lab hours		**56**

Suggested Books/Resources:

1. Web Enabled commercial Application development using HTML,DHTML, Java Script, Perl CGI" by Ivan Bayross, BPB Publication
2. "Internet and World Wide Web – How to Program" by Deitel, Deitel and Nieto ,Pearson Education Asia Publication
3. "PHP and MYSQL Manual" by Simon Stobart and Mike Vassileiou
4. "PHP and MYSQL Web Development" by Luke Welling and Laura Thomson(Pearson Education

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Attendance	15 Marks
4	Lab Assessment	45 Marks
	Total	100 marks

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Average
CO1	3	3	3	2	2	3	2	2	2	3	1	3	**2.4**
CO2	3	3	3	2	3	2	3	2	2	3	1	3	**2.5**
CO3	3	3	3	2	2	3	1	2	3	3	1	3	**2.4**
CO4	3	3	3	2	3	3	2	2	3	3	1	3	**2.6**
CO5	3	3	3	2	3	3	2	2	3	3	1	3	**2.6**
CO6	3	3	3	2	3	3	2	2	2	3	1	3	**2.5**
Average	**3**	**3**	**3**	**2**	**2.7**	**2.8**	**2**	**2**	**2.5**	**3**	**1**	**3**	

Approved in Academic Council held on 25.10.2018

Applied Medical Signal Processing

COURSE CODE:

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

1. To introduce different biomedical signals.
2. To apply different methods to analyze and filter the signals.
3. To detect events in signals used for diagnosis.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Identify and reproduce signal processing methods used in forefront biomedical sciences	Familiarity
CO-2	Able to filter out the noise and artifacts from the medical signals.	Usage
CO-3	Critically assess the appropriateness of biomedical signal processing techniques for various problems in the field	Usage
CO-4	Evaluate the effectiveness of techniques applied to biomedical signals against specific benchmarks	Assessment

Course Contents:

Unit	Contents	Lectures required
1	Introduction: Preliminaries, Medical signal origin & dynamics (ECG, EEG, EMG etc.)	4
2	Filtering for removal of artifacts: Statistical Preliminaries, Time domain filtering (Synchronized Averaging, Moving Average, Derivative-based operator), Frequency Domain Filtering (Notch Filter), the Weiner Filter, Adaptive Filter and related design problems.	12
3	Waveform Analysis: Illustrations of problem with case studies, Morphological analysis, transform analysis, correlation coefficient, Periodogram, Averaged periodogram, Blackman-Tukey Spectral Estimator, Daniell's Spectral Estimator, Measures derived from PSD	9
4	Modeling of Biomedical Systems: Motor unit firing pattern, Autoregressive model, Autocorrelation method, Parametric modeling, Levinson-Durbin algorithm, Covariance method, Spectral matching and parameterization, Model order selection	12

5	Pattern classification and diagnostic decision: Illustrations of problem with case studies, Feature extractions from medical signals, supervised and unsupervised pattern classification, Reliability of features, classifiers and decisions.	5
Total lectures		42

Suggested Text Book(s):

1. Rangaraj M. Rangayyan, Biomedical Signal Analysis, 2nd Ed., Wiley, 2015.
2. Willis J. Tompkins , Biomedical Digital Signal Processing, 10th Ed., Prentice Hall, 2011
3. D C Reddy, Biomedical Signal Processing: Principles and Techniques, 1st Ed., Tata McGraw-Hill Publishing Co. Ltd, 2005
4. J G Webster, Medical Instrumentation: Application & Design, 3rd Ed. John Wiley & Sons Inc., 2007

Suggested Reference Book(s):

1. R. S Khandpur and Raghbir Khandpur: Biomedical Instrumentation, 2nd Ed., McGraw-Hill Education , 2003.
2. Leslie Cromwell, Fred Weibell J, Erich Pfeiffer. A: Biomedical Instrumentation and Measurements, Prentice-Hall India, 2nd Edition, 1997.
3. C Raja Rao, S K Guha, Principles of Medical Electronics and Biomedical Instrumentation, 1st Ed., Universities Press, 2001

Other useful resource(s):

Link to NPTEL course contents:

1. https://nptel.ac.in/courses/108105101/
2. https://onlinecourses.nptel.ac.in/noc19_ee23/preview

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes(2) -10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Applied Medical Signal Processing)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	1	3	2	3	2	2	3	2	2	1	3	2.28
CO-2	3	3	3	3	3	1	1	2	2	2	1	3	2.25
CO-3	3	3	3	3	3	1	1	2	2	2	1	3	2.25
CO-4	3	3	3	3	3	1	1	2	2	2	1	3	2.25
Average	2.75	2.5	3	2.75	3	1.25	1.25	1.25	2	2	1	3	

ARM based Embedded System Design

COURSE CODE:13B1WCI731

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

1. Learn all the assemblyinstructions ofARM7TDMI processor and its internalfunctioning, enabling students to understand any otherprocessor architectures at ease.
2. Provide good understanding of how coprocessors areinterfaced with ARM core and how coprocessors canbe programmed.
3. Provide an in-depth understanding of the Floating-point representation and the VFP coprocessor
4. Cover the details of cache architectures, AMBA bus,virtual memory management concepts with the detailedexplanation on the Memory Management Unit (MMU)and Memory Protection Unit (MPU).
5. Give good overview of various peripherals used withARM core and it basic functioning
6. Touch upon later versions ofARM7 processor and their features and new developments.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Describe the architecture of a typical embedded RISC processor (e.g. ARM Cortex-M3).	Familiarity
CO-2	Develop an understanding of the instruction set and addressing modes.	Assessment
CO-3	Write programs that exercise a range of typical microcontroller peripherals (e.g. GPIO, USART, ADC, etc...)	Assessment
CO-4	Use a typical toolchain to implement and test simpleembedded microcontroller applications in C and assembly language	Assessment
CO-5	Evaluate the requirements for embedded Real Time Operating Systems (RTOS)	Usage

Course Contents:

Unit	Contents	Lectures required
1	**An Introduction to Processor Design:**Processor architecture and organization, Abstraction in hardware design, MU0 - a simple processor,Instruction set design, Processor design trade-offs, The Reduced Instruction Set Computer, Design for low power consumption	4
2	**The ARM Architecture:** The Acorn RISC Machine, Architectural inheritance, The ARM programmer's model, ARM development tools Example	4
3	**ARM Assembly Language Programming:** Data processing instructions, Data transfer instructions, Control flow instructions Writing simple assembly language programs ,Examples	6
4	**ARM Organization and Implementation:**3-stage pipeline ARM organization, 5-stage pipeline ARM organization, ARM instruction execution ,ARM implementation, The ARM coprocessor interface, Examples and exercises	6
5	**The ARM Instruction Set:** 1 Introduction, Exceptions, Conditional execution, Branch and Branch with Link (B, BL), Branch, Branch with Link and eXchange (BX, BLX), Software Interrupt (SWI) , Data processing instructions, Multiply instructions, Count leading zeros (CLZ - architecture v5T only), Single word and unsigned byte data transfer instructions, Half-word and signed byte data transfer instructions, Multiple register transfer instructions, Swap memory and register instructions (SWP), Status register to general register transfer instructions, General register to status register transfer instructions Coprocessor instructions, Coprocessor data operations, Coprocessor data transfers, Coprocessor register transfers, Breakpoint instruction (BRK - architecture v5T only), Unused instruction space, Memory faults ,ARM architecture variants	10
6	**Architectural Support for High-Level Languages:** Abstraction in software design, Data types, Floating-point data types, The ARM floating-point architecture, Expressions ,Conditional statements Loops, Functions and procedures Contents, Use of memory, Run-time environment	6
7	**The Thumb Instruction Set:** The Thumb bit in the CPSR, The Thumb programmer's model, Thumb branch instructions, Thumb software interrupt instruction, Thumb data processing instructions ,Thumb single register data transfer instructions, Thumb multiple register data transfer instructions, Thumb breakpoint instruction, Thumb implementation, Thumb applications	6
Total lectures		**42**

Suggested Text Book(s):

- ARM System Developers Guide, Designing andOptimizing System Software, by Andrew N.SLOSS,Dominic SYMES and Chris WRIGHT,ELSEVIER, 3004
- Steve Furber, "ARM System-on-Chip Architecture", 2nd Edition, Addison Wesley Professional

Other useful resource(s):

1. ARM Architecture Reference Manual (local copy)
   ARM7TDMI Technical Reference Manual (local copy)
   ARM7TDMI Instruction Set Reference (local copy)
2. ARM7TDMI Quick Reference (local copy)
3. An Introduction to the GNU Assembler
4. An Introduction to the GNU Compiler
5. An Introduction to GNU Debugger
6. ARMv4T Partial Instruction Set Summary
   Pete Cockerell has put the text of his 1987 book "ARM Assembly Language Programming" on the web (local copy)
7. A book by Peter Knaggs and Stephen Welsh, ARM: Assembly Language Programming @2004 - download for free (local copy)
8. ARM System-On-Chip Architecture (2nd Edition) by Steve Furber (the father of the ARM processor) - download for free (local copy)

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes(2) -10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

ARM based Embedded System Design)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	**1.8**
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	**2**
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	**1.8**
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	**2.1**
CO-5	2	3	3	3	2	1	1	1	2	3	3	3	**2.3**
Average	**2**	**2.6**	**2.6**	**2.6**	**2.4**	**1**	**1**	**1**	**2**	**2.4**	**1.8**	**2.2**	**2**

Building Drawing

COURSE CODE:18B17CE771

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 1-0-4

Pre-requisite: Individuals with knowledge of engineering drawing, understanding of architectural terminology and compatible with using windows operating system.

Course Objectives:

1. Learn the AutoCAD user interface.
2. Create sites, profiles, and cross-sections.
3. Use plan production tools to create plan and profile sheets.
4. Prepare detail drawings and Generate perspective view.
5. Creating a 3D building model with walls, curtain walls, windows, and doors
6. Adding floors, ceilings, and roofs to the building model.
7. Adding component features, such as furniture and equipment.
8. Setting up sheets for plotting with text, dimensions, details, tags, and schedules.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Create, edit, view, and analyze surfaces and sites, profiles, and cross-sections, Prepare detail drawings	Assessment
CO-2	Generate perspective view of simple buildingand use plan production tools to create plan and profile sheets.	Assessment
CO-3	Adding floors, ceilings, and roofs to the building model, component features, such as furniture and equipment.	Assessment
CO-4	Creating a 3D building model with walls, curtain walls, windows, and doors	Assessment

Course Contents:

Unit	Contents	Lectures
1	Product Overview, AutoCAD Civil 3D Workspaces, Start Tab, AutoCAD Civil 3D User Interface, AutoCAD Civil 3D Toolspace	2
2	Lines and Curves, Introduction to Parcels, Creating and Editing Parcels by Layout Overview, Surface Process, Breaklines and Boundaries, Surface Analysis Tools	2
3	Creating Alignments from Objects, Creating and Modifying Alignments, Labels and Tables, Create Profiles from Surface, Generate perspective view of simple building	2
4	Creating a Corridor, Creating Sections, Plan Production Tools, Prepare detail drawings for single and two storied residentialbuilding	2
5	Introduction to BIM and Autodesk Revit, Basic Sketching and Modify Tools, Setting Up Levels and Grids	2

6	Working with Doors and Windows, curtain walls, views, Adding Components, Modeling Floors, ceilings and roofs, Stairs, Railings, and Ramps	2
7	Creating Construction Documents, Adding Tags and Schedules and Creating Details in building	2
Total lectures		**14**

List of Experiments:

Sr. no.	Description	Hours
1	AutoCAD Civil 3D User Interface, AutoCAD Civil 3D Toolspace, Draw symbols, conventions and Abbreviations	3
2	Lines and Curves, Introduction to Parcels, Creating and Editing Parcels by Layout Overview, Surface Process, Breaklines and Boundaries	3
3	Surface Process, Breaklines and Boundaries	3
4	Generate perspective view of simple building	3
5	Plan Production Tools, Prepare detail drawings for single and two storied residential building	3
6	Introduction to BIM and Autodesk Revit, Basic Sketching and Modify Tools	3
7	Doors and Windows, curtain walls	3
8	Floors, ceilings and roofs, Stairs, Railings, and Ramps	3
9	Adding Tags and Schedules and Creating Details in building	4
Total		**28**

Suggested Textbook(s):

- V. B. Sikka, "Civil engineering drawing", Charotar Publication
- Gurcharan singh, Subash chander, "Civil engineering drawing", published by Standard Publishers Distributors
- R. S. Malek G. S. Meo, "Civil engineering drawing", Computech Publication Ltd New Asian

Other useful resource(s):

1. nptel.ac.in/
2. www.Autodesk.com
3. www.drawingnow.com
4. www.learn-to–draw.com

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Attendance	15 Marks
4	Lab Assessment	45 Marks
	Total	100 marks

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course Outcomes	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO1	3	2	3	2	1	2	2	1	3	3	1	3	**2.16**
CO2	3	2	3	3	3	2	2	2	3	2	2	3	**2.5**
CO3	2	2	2	2	1	2	3	2	2	2	2	3	**2.08**
CO4	2	2	3	2	1	2	2	1	2	1	2	2	**1.83**
Average	**2.5**	**2**	**2.75**	**2.25**	**1.5**	**2**	**2.25**	**1.5**	**2.5**	**2**	**1.75**	**2.75**	

Bioprocess Modelling and Simulation

COURSE CODE:

COURSE CREDITS: 3

CORE/ELECTIVE: Elective

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

The objective of this course is to learn the modeling and optimization approaches for model and optimize the different biotechnological processes. This approach is helpful to scale up the biotechnologal process and improves the yield of Biotechnological products.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Introduction and Importance of Modelling in Bioprocess technologies	Familiarity
CO-2	Role of optimization in enhanced yields in Bioprocess systems	Familiarity
CO-3	Necessity of Design of experiments in modeling and optimization approaches	Familiarity
CO-4	Types of modeling and optimization approaches for Bioprocess systems	Usage
CO-5	Application of modeling coupled optimization tools for bioprocess systems	Usage

Course Contents:

Unit	Contents	Lectures required
1	Introduction to Modeling and Different Types of models	**5**
2	Introduction to optimization and classical optimization techniques	5
3	Introduction to experimental Design and Types of Experimental Designs	**8**
4	Modelling & optimization through Response Surface Methodology and Taguchi Methodology	**8**

5	Modeling based on neural networks and Experimental validation of neural network models	6
6	Evolutionary and swarm intelligence based optimization approaches for optimization of Biological process	10
Total lectures		**42**

Suggested Text Book(s):

4. Modelling and Simulation by G. Francis,
5. Modelling and Optimization of Biotechnological Processes by Chen, Nguang and Chen, Springer
6. Biologically Inspired Algorithms for Financial Modelling by Brabazon · Michael O'Neill, Springer
7. Modelling microbial responses in Food by McKeller and Lu, CRC Press
8. Engineering optimization by S.S.Rao, Wily-Interscience
9. Extraction and optimization of Food Engineering by Coustantina Tzia, Marcell-Dekker
10. Design and optimization in Organic synthesis by Carlson and Carlson, Elsevier
11. Design and Analysis of Experiments by Dean and Voss, Springer
12. Design and Analysis of Expeiments by Montgomery, John Wiley & Sons
13. Design of Experiments Using the Taguchi Approach by Roy, Ranjit K, John Wiley & Sons, Inc. (US)
14. Design and Analysis of Experiments by Hinkelmann and Kempthorne, Wiley Interscience
15. Differential Evolution by Feoktistov, Springer
16. Response surface methodology and related topics by Khuri, World Scientific
17. Particle swarm optimization by Clerc, ISTE
18. Soft computing by D.K.Prathihar, Narosa Publishers

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	3	3	2	2	1	1	1	1	1	1	
CO-2	3	3	3	3	3	1	1	1	1	1	1	3	
CO-3	3	3	2	3	2	3	2	1	1	1	2	1	

CO-4	3	3	3	2	3	2	1	1	1	1	1	1	
CO-5	2	2	3	3	3	3	1	1	1	1	1	1	
Average													

Construction Financial Management

COURSE CODE:

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Construction Technology and Management, Costing and Estimation

Course Objectives:

1. To understand the Economics in civil engineering
2. To understand concept of alternatives for decision making
3. To analyse financial returns
4. To evaluate the value added tax.
5. To understand the concept financial management, construction costing and financial statement analysis

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Understand the Economics in civil engineering	Familiarity
CO-2	Understand concept of alternatives for decision making	Familiarity
CO-3	Analyze financial returns	Assessment
CO-4	Evaluate the value added tax	Usage
CO-5	Understand the concept financial management, construction costing and financial statement analysis	Assessment

COURSE CONTENT

S No.	Description	Lectures
1.	**Economics :** Role of Civil Engineering in Industrial Development - Support matters of Economy as related top Engineering- Market demand and supply - Quality control and Quality Production -Audit in economic law of returns, governing production	**8**
2.	**Equivalence Factors :** Time value of money, Quantifying alternatives for decision making, Cash flow diagrams, Equivalency - Single payment in the future - Present payment compared to uniform series payments - Future payment compared to uniform series payments - Arithmetic gradient, Geometric gradient	**8**
3.	**Financial Returns Analysis:**Comparison of alternatives: Present, future and annual worth method of comparing alternatives, Rate of return, Incremental rate of return, Break-even comparisons, Capitalized cost analysis, Benefit-costanalysis.	**8**
4.	**Evaluating Alternative Investments:**Real Estate - Investment Property, Equipment Replace Analysis, and Depreciation – Tax before and after depreciation – Value Added Tax (VAT) – Inflation.	**6**

5.	**Construction Costing:** Financial statements – Profit and loss, Balance sheets, Financial ratios, Working capital management, Inventory valuation, Mortgage Financing - International financial managementforeign currency management.Cost estimating: Types of Estimates, Approximate estimates – Unit estimate, Factor estimate, Cost indexes. Fixed contract Pricing- Cost plus pricing- Escalation clause-Construction cost control, Personnel costs, Equipment costs, Job in directs and markup.Balance sheet and Profit and Loss accounts – ratios analysis, Fund flow statement, Cash flow statement, Working Capital Management, Financial Control - Management accounting.	**12**
	TOTAL LECTURES	**42**

Suggested Textbook(s):

4. Anthony Higham,Carl Bridge, Peter Farrell, (2016), Project Finance for Construction, Routledge
5. Senthil, L. Madan and N. Robindro Singh (2011), Engineering Economics and Cost Analysis, Lakshmi Publications, New Delhi.

Suggested Reference Book(s):

1. Steven J. Peterson , (2012), Construction Accounting & Financial Management, Pearson, USA
2. Karl E. Case, Ray C. Fair and Sharon E. Oster (2017), Principles of Economics, Pearson, New Delhi.
3. Leland Blank and Anthony Tarquin, (2017), Engineering Economy, 7th Edition, McGraw Hill Education, New Delhi.
4. Bose, D. C., (2010), Fundamentals of Financial management, 2nd ed., PHI, New Delhi.

Other useful resource(s):

1. Link to NPTEL course contents: https://nptel.ac.in/courses/105/103/105103023/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) -10 Attendance - 5

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Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course Outcomes (Construction Financial Management)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	3	3	2	2	1	2	3	2	2	3	**2.4**
CO-2	3	3	3	3	2	2	1	2	3	2	2	2	**2.3**
CO-3	3	3	3	2	2	2	1	2	2	2	2	3	**2.2**
CO-4	3	3	3	2	2	1	1	2	3	3	2	2	**2.2**
CO-5	3	2	3	3	3	1	1	3	3	3	3	2	**2.5**
Average	**3**	**2.8**	**3**	**2.6**	**2.2**	**1.6**	**1**	**2.2**	**2.8**	**2.4**	**2.2**	**2.2**	

Construction Management Computations

COURSE CODE: 18B1WCE641

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 1-0-4

Pre-requisite: Individuals with knowledge of project management principles and hands-on experience with Windows operating system are the ideal participants for this course.

Course Objectives:

1. Create a project.
2. Create a Work Breakdown Structure, Relationships & Schedule the project
3. Analyze resources and cost, Manage risk.
4. Calculating various quantities in building construction
5. Preparation of schedule of bars and tenders

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Learn to Create a project, add activities and Create relationships	Assessment
CO-2	Learn to Assign and analyze resources and Analyze project performance	Assessment
CO-3	Learn to calculate various quantities related to building construction work	Assessment
CO-4	Learn to prepare schedule of bars and tenders.	Assessment

Course Contents:

Unit	Contents	Lectures
1	**Primavera Overview and Configuration:** Project Management Life Cycle, Understanding Data in P6, Overview and Navigation	2
2	**Structuring Projects:** Creating a Project, creating a Work Breakdown Structure, Adding Activities, Calendars, Creating Relationships, Scheduling, Assigning Constraints	2
3	**Implementing the Schedule:** Assigning Constraints, Customizing Activity Views, Understanding Roles and Resources, Assigning Roles and Resources, Project Workspace	2
4	**Updating and Managing the Schedule:** Optimizing the Project Plan, Base lining the Project Plan, Methods of Applying Progress, Executing the Project Plan, Analysing the Updated Project, Portfolios and Dashboards	2
5	**Estimator:** Creating new project, finding earthwork, masonry calculation, openings, plastering	3

6	**Estimator:** Preparing schedule of bars, prepare a building, chart, graphs and tenders.	3
Total lectures		**14**

List of Experiments:

Sr. no.	Description	Hours
1	Introduction to software Understanding Data in P6 and Overview and Navigation	3
2	How to Create a Project and create a Work Breakdown Structure	3
3	Adding Activities, Calendars and Creating Relationships in Primavera	3
4	Scheduling and Assigning Constraints in Primavera	3
5	How to Assign Constraints, Customize Activity Views and Assign Roles and Resources	3
6	Methods of Applying Progress and Executing the Project Plan in Primavera	4
7	Creating new project, finding earthwork	3
8	How to calculate masonry, openings and plastering	3
9	Preparing schedule of bars, prepare a building, chart, graphs and tenders.	3
Total		**28**

Suggested Textbook(s):

1. Kumar Niraj Jha, "Construction project management: Theory and Practices", published by Dorling Kindesley (2011)
2. Punamia & Khandelwal,"CPM and PERT", Laxmi Publications Ltd.
3. B. N. Dutta, "Estimation and Costing", USB Publisher & Distributors.

Other useful resource(s):

1. nptel.ac.in/

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Attendance	15 Marks
4	Lab Assessment	45 Marks
	Total	100 marks

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course Outcomes	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO1	3	2	3	2	1	2	2	1	3	3	1	3	**2.16**
CO2	3	2	3	3	3	2	2	2	3	2	2	3	**2.5**
CO3	2	2	2	2	1	2	3	2	2	2	2	3	**2.08**
CO4	2	2	3	2	1	2	2	1	2	1	2	2	**1.83**
Average	**2.5**	**2**	**2.75**	**2.25**	**1.5**	**2**	**2.25**	**1.5**	**2.5**	**2**	**1.75**	**2.75**	

Approved in Academic Council held on 28 July 2021

Construction Planning and Control

COURSE CODE:

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Construction Technology and Management

Course Objectives:

1. To study the elements of construction planning and scheduling and to apply appropriate tools and techniques like networks and coding systems.
2. To study the monitoring of projects through cost control
3. To study the elements of quality control and safety of construction projects
4. To study the concept of gathering and using project information

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO1	Understand the basic development of construction plans	Assessment
CO2	Evaluate the construction schedules using techniques and methods	Usage
CO3	Assessment of project budget, forecasting of cost control	Assessment
CO4	Understanding and framing of quality assurance and quality control	Usage
CO5	Understand information and database processing models	Usage

COURSE CONTENT:

S No.	Content	Lectures
1.	**BASIC CONCEPTS IN CONSTRUCTION PLANS:** Basic Concepts in the Development of Construction Plans - Choice of Technology and Construction Method - Defining Work Tasks - Defining Precedence Relationships Among Activities -Estimating Activity Duration. Estimating Resource Requirements for Work Activities -Coding Systems.	**5**
2.	**CONSTRUCTION SCHEDULES:** Relevance of Construction Schedules - The Critical Path Method - Calculations for Critical Path Scheduling -Activity Float and Schedules -Presenting Project Schedules Critical Path Scheduling for Activity-on-Node and with Leads. Lags and Windows . - Calculations for Scheduling with Leads, Lags and Windows - Resource Oriented Scheduling - Scheduling with Resource Constraints and Precedence - Use of Advanced Scheduling Techniques - Scheduling with Uncertain Duration -Calculations for Monte Carlo Schedule Simulation - Crashing and Time/Cost Trade-offs – Scheduling in Poorly Structured Problems - Improving the Scheduling Process	**14**
3.	**INTRODUCTION TO PROJECT BUDGET:** The Cost Control Problem -The Project Budget - Forecasting for Activity Cost Control - Financial Accounting Systems and Cost Accounts - Control of Project Cash Flows – Schedule Control - Schedule and Budget Updates - Relating Cost and Schedule Information	**18**

4.	**QUALITY AND SAFETY MANAGEMENT:** Quality and Safety Concerns in Construction -Organizing for Quality and Safety – Work and Material Specifications -Total Quality Control -Quality Control by Statistical Methods - Statistical Quality Control with Sampling by attributes – Statistical Quality Control with Sampling by Variables – Safety.	**3**
5.	**PROJECT INFORMATION :**Types of Project Information - Accuracyand Use of Information -Computerized Organization and Use of Information -Organizing Information in Databases - Relational Mode of Databases - Other Conceptual Models of Databases - Centralized - Database Management Systems - Databases and Applications Programs – Information - Transfer and Flow.	**2**
	TOTAL LECTURES	**42**

Suggested Textbook(s):

1. Chitkara. K.K. "Construction Project Management: Planning Scheduling and Control", Tata McGraw Hill Publishing Company, New Delhi, 2008.
2. Calin M. Popescu, Chotchal Charoenngam, "Project Planning, Scheduling and Control in Construction: An Encyclopedia of terms and Applications", Wiley, New York, 2005.

Reference book:

1. Chris Hendrickson and Tung Au, "Project Management for Construction – Fundamental Concepts for Owners, Engineers, Architects and Builders", Prentice Hall Pittsburgh, 2000.
2. Moder, J., C. Phillips and E. Davis, "Project Management with CPM, PERT and Precedence Diagramming", Van Nostrand Reinhold Company, Third Edition, 2003.
3. Willis, E. M., "Scheduling Construction Projects", John Wiley & Sons, 2006.
4. Halpin, D. W. "Financial and Cost Concepts for Construction Management", John Wiley & Sons. New York, 2005.

Other useful resource(s):

1. https://nptel.ac.in/noc/courses/noc17/SEM2/noc17-ce16/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) -10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course Outcomes (Construction Planning and Control)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	2	2	2	2	3	x	x	1	1	1	3	**2**
CO-2	3	3	2	2	2	3	x	x	2	1	1	3	**2.2**
CO-3	3	3	3	2	2	2	x	x	2	2	1	3	**2.3**
CO-4	3	3	3	3	3	2	x	x	2	2	3	3	**2.7**
CO-5	3	3	3	3	3	2	x	x	2	2	3	3	**2.7**
Average	**3**	**2.8**	**2.6**	**2.4**	**2.4**	**2.4**	**0**	**0**	**1.8**	**1.6**	**1.8**	**3**	

Construction Safety and Health

COURSE CODE:

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Building material and Construction Technology.

Course Objectives:

1. To understand the hazards and controls of various phases of construction.
2. To understand safety and health regulations as per BIS and consensus standards applicable to the construction industry.
3. To understand the requirements of safe workplaces, updates of regulations, techniques of planning for safety in the construction process.
4. To analyze the basic hazards related to construction activities.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Identify common hazards of construction	Familiarity
CO-2	Understand and interpret safety and health regulations (BIS) as they pertain to construction activities	Assessment
CO-3	Analyse and recommend appropriate control measures to eliminate or minimize hazards	Assessment
CO-4	Apply the knowledge for conducting hazard assessment and designing regulatory compliance pertaining to construction activity	Usage

Course Contents:

Unit	Contents	Lectures
1	**Introduction to health, safety and Environment:**Need for Safety in Indian Construction Sites, Introduction to Industrial Safety, Introduction to Health Management, Introduction to Environment Management	5
2	**Enforcement of health and safety laws:**Introduction, Health and Safety Commission, IS Safety Codes, Powers of the Factory Inspectorate, Methods to Ensure Compliance, General Requirements & Legislation for Protective Clothing and Safety Equipment	8
3	**Hazards of construction and their prevention:** Physical Injury Hazards, Excavation, Scaffolding, Formwork, Structural Framework, Roof work, Cranes and Heavy Lifting, Tunnelling, Sewers and Confined Spaces, Demolition and Contaminated Sites, Work over Water, Health Hazards, Legislation, Chemical Hazards, Physical Hazards, Biological Hazards, Site Arrangements for Health, Safety and Welfare.	15

4	**Safety Policies**: Legislation, Health and Safety Policy Statements, Safety Organization, Safety Management Contracting, Subcontracting, Safety Groups and Group Safety Schemes	**8**
5	**Management systems for safe construction:**Pre-contract Activities, Survey and Investigation, Design and Specification, Design Aids for Safe Construction, Risk, Reliability, The Need for Information on Safety	**6**
Total lectures		**42**

Suggested Textbook(s):

1. Bhattacharjee, S.K. (2011) Safety Management in Construction, Khanna Publishers
2. Reese, C.D. & Eidson, J.V. (2006) Handbook ofOSHA Construction Safety and Health, Taylor & Francis.
3. Holt, A.S.J. (2005) Principles of Construction Safety, Wiley-Blackwell Publishers
4. Few IS Codes & journal papers.

Suggested Reference Book(s):

1. Hinze, J.W. (1997) Construction Safety, Prentice Hall
2. MacCollum, D.V. (1995) Construction SafetyPlanning, John Wiley & Sons
3. Lingard, H. & Rowlinson, S. (2005) Occupationalhealth and Safety in Construction Project Management, Spon Press.
4. MacCollum, D.V. (2007) Construction Safety Engineering Principles, McGraw Hill Publishers
5. Li, R.Y.M. & Poon, S.W. (2013) Construction Safety, Springer Publishers

Other useful resource(s):

1. https://nptel.ac.in/courses/105/102/105102206/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) -10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Construction Safety and Health)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	3	2	2	3	2	2	2	3	2	1	1	**2.08**
CO-2	3	2	2	2	3	2	2	2	3	1	1	2	**2.08**
CO-3	3	2	3	2	3	3	2	3	3	1	2	1	**2.33**
CO-4	2	3	3	2	3	2	3	2	3	1	2	1	**2.25**
Average	**2.5**	**2.5**	**2.5**	**2**	**3**	**2.25**	**2.25**	**2.25**	**3**	**1.25**	**1.5**	**1.25**	

Approved in Academic Council held on 28 July 2021

Construction Techniques

COURSE CODE:

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Construction Technology and Management

Course Objectives:

1. To study the substructure construction techniques.
2. To create awareness on tall structure construction elements
3. To know about the techniques used for large span structures
4. To study the elements of repair construction.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO1	Students with be familiar with substructure construction techniques	Familiarity
CO2	Students will be able to evaluate construction of tall structures	Assessment
CO3	Students will be able to understand construction of tunnels, bridges and domes	Assessment
CO4	Students will be able to understand the construction techniques related to lattice towers, transmission lines and offshore construction.	Assessment
CO5	Students will be able to evaluate and suggest suitable repair measures for various construction issues.	Usage

COURSE CONTENT:

S.No	Description	Hours
1	**SUB STRUCTURE CONSTRUCTION**: Box Jacking: Need – elements – concept – precautions – advantages. Pipe jacking: Technique – factors – applications – advantages. Diaphragm walls – methods – sheet piles – applications – advantages. Piling techniques: Classifications – factors. Well and caisson: Types – sinking method – precautions. Coffer dam: Purpose – types – techniques. Cable anchoring – screw anchor – necessity- applications. Grouting: Need – materials – techniques – applications – guniting and shotcreting. Well points - dewatering – techniques	**12**
2	**TALL STRUCTURES CONSTRUCTION**: Concrete in tall buildings – types of concrete pumps – factors – blockage – causes - clearing –safety. Slip form techniques: Vertical - chimney – horizontal – concrete paving methods. Suspended form work: Purpose – methods – advantages - erection techniques. Prestressing techniques – in situ prestressing in high rise structures.	**8**

3	**LARGE SPAN STRUCTURES CONSTRUCTION**: Tunnelling: Purpose – aspects – shafts – mucking – construction techniques – advantages – trenchless technology. Bow string bridges: Systems – arrangements – advantages. Suspension and cable stayed bridges: Parallel – radial patterns – concept. Domes: Types – structural framing – erection methods. Aerial transportations – components – advantages – applications.	**8**
4	**SPECIAL STRUCTURE CONSTRUCTION**: Lattice tower: Definition – techniques. Rigging of transmission line structures: Definition –precaution – stages involved. Advanced construction techniques in offshore construction practice: Various operations – under water concrete - vacuum dewatering of concrete flooring. Articulated structure – definition – mechanism	**6**
5	**REPAIR AND STRENGTHENING TECHNIQUES**: Mud Jacking: Techniques – behavior of slab – advantages. Micro piles: Uses – stages – applications- benefits. Shallow profile pipeline laying – procedure – specifications – sub aqueous pipelines –laying methods. Sheet piles protection techniques. Water proofing: Need – above and below ground. Under pinning: Need – methods. Demolition and dismantling: Principles – methods – modern demolition techniques – controlled demolition – mechanical method – hydro demolition – advantages – sequence of demolition – beams – columns – walls – general sequence.	**8**
Total Lectures		**42**

Suggested Textbook(s):

1. Roy Chudley, Roger Geeno ,"Advanced Construction Technology" Latest Edition.
2. Ponnuswamy .S,"Bridge Engineering "Second Edition.
3. Sankar, S.K. And Saraswati, S., Construction Technology, Oxford University Press, New Delhi, 2008.
4. Gahlot .P.S & Sanjay Sharma ,"Building repair and maintenance management "CBS Publications.2006

Suggested/Resources:

1. Robertwade Brown, "Practical Foundation Engineering Handbook", McGraw Hill Publications, 2005.
2. Patrick Powers .J, "Construction Dewatering: New Methods and Applications" John Wiley & Sons, 2002.
3. Micheal T.Kubal ,"Construction Waterproofing Handbook".

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) -10 Attendance - 5

Approved in Academic Council held on 28 July 2021

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course Outcomes (Construction Techniques)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO1	3	2	3	2	1	2	2	1	3	3	1	3	**2.17**
CO2	3	2	3	3	3	2	x	x	3	2	x	3	**2.67**
CO3	2	2	2	2	1	2	3	2	2	2	2	3	**2.08**
CO4	2	2	3	2	1	2	2	1	2	1	2	2	**1.83**
CO5	2	1	2	2	3	2	2	1	3	2	3	2	**2.08**
Average	**2.4**	**1.8**	**2.6**	**2.2**	**1.8**	**2**	**2.25**	**1.25**	**2.6**	**2**	**2**	**2.6**	

Heavy/Civil Construction Equipment, Methods, and Management

COURSE CODE:

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Building material and Construction Technology, Geotechnical Engineering, Pavement Construction

Course Objectives:

1. To understand the elements of equipment cost and evaluating investment alternatives.
2. To familiarize with construction equipment and their capabilities
3. To properly select heavy equipment based on applications, utilization, productivity and other factors.
4. To develop basic understanding of unit price and earthwork quantities.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	To associate the knowledge of construction of sub structures and super structures and analyze the techniques of erection of construction units	Familiarity
CO-2	To demonstrate basic knowledge about construction equipment and machineries and clearly explain about the hauling and conveying equipment.	Assessment
CO-3	To identify and manage with respect to time and their motion and movements	Usage
CO-4	To clearly explain the equipments used for aggregate and concreting and understand clearly the latest construction equipments used in industry	Usage

Course Contents:

Unit	Contents	Lectures
1	**CONSTRUCTION EQUIPMENT MANAGEMENT:** Identification – Planning - Equipment Management in Projects - Maintenance Management – Replacement - Cost Control of Equipment - Depreciation Analysis – Safety Management	10
2	**EQUIPMENT FOR EARTHWORK:** Fundamentals of Earth Work Operation, Earth Moving Operations, Types of Earth Work Equipment - Tractors, Motor Graders, Scrapers, Earth Movers	10
3	**OTHER CONSTRUCTION EQUIPMENTS:** Equipment for Dredging, Trenching, Tunnelling, Drilling, Blasting - Equipment for Compaction - Erection Equipment - Types of pumps used in Construction - Equipment for Dewatering and Grouting – Foundation and Pile Driving Equipment –Equipment for Demolition	6

4	**MATERIALS HANDLING EQUIPMENT**: Storage Handling equipment – Engineered Systems – Industrial Trucks – Bulk Material handling – OnRails Transfer Cart –Conveyors - Hauling Equipment – tractors, Trucks, Tippe	**8**
5	**EQUIPMENT FOR PRODUCTION OF AGGREGATE AND CONCRETING:** Crushers – Feeders - Screening Equipment – Pneumatic - Batching plants – Mixers – Concrete Pumps – Transit Mixers – Dumpers – Concrete Placers - Handling Equipment - Hauling, Pouring and Pumping Equipment – Transporters	**8**
Total lectures		**42**

Suggested Textbook(s):

1. Sharma S.C., "Construction Equipment and Management", 5th edition, Khanna Publishers, New Delhi, 2011.
2. Dr.MaheshVarma, "Construction Equipment and its planning and Application",Metropolitan Book Company, New Delhi. 1988

Suggested Reference Book(s):

1. Peurifoy, R.L., Ledbetter, W.B. and Schexnayder, C., "Construction Planning, Equipment and Methods", McGraw Hill, Singapore, 2006
2. Deodhar, S.V., "Construction Equipment and Job Planning",4th edition, Khanna Publishers, New Delhi, 2010

Other useful resource(s):

1. Link to SWAYAM course content:https://onlinecourses.nptel.ac.in/noc21_ce21/preview

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) -10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Heavy/Civil Construction Equipment, Methods, and Management)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	3	2	2	3	2	2	2	3	2	1	1	**2.08**
CO-2	3	2	2	2	3	2	2	2	3	1	1	2	**2.08**
CO-3	3	2	3	2	3	3	2	3	3	1	2	1	**2.33**
CO-4	2	3	3	2	3	2	3	2	3	1	2	1	**2.25**
Average	**2.5**	**2.5**	**2.5**	**2**	**3**	**2.25**	**2.25**	**2.25**	**3**	**1.25**	**1.5**	**1.25**	

Course description of Open Electives

Introduction to C++ Programming

COURSE CODE: 19B1WCI733

COURSE CREDITS: 2

ELECTIVE: OPEN

ELECTIVE **L-T-P:** 2-0-0

Pre-requisite: C Programming

Course Objectives:

The object oriented programming paradigm is one of the popular programming paradigms of today. Due to its characteristics object orientation has added new dimensions in the software development process. In this course concept of Object Oriented Programming (OOP) is introduced and for this purpose C++ programming language is being used. C++ a very powerful general purpose programming language, which supports object oriented programming paradigm. This course covers basics of C++ programming language which includes data types, variables, operators, and array and pointers. Also, object oriented features such as class and objects, inheritance, polymorphism are covered in this course. Finally exceptions handling, I/O operations and STL are explained.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Learn the concepts of an Object-Oriented Programming	Familiarity
CO-2	Learn to define class, objects, object members, class members, data members, constructors and destructors	Usage
CO-3	Learn the concepts of Inheritance and Polymorphism in C++	Usage
CO-4	Learn the advanced features of C++, such as file handling, templates, and exception handling	Usage

Course Contents:

S No.	Contents	Lectures required
1	Object Oriented Programming Structured vs. Object Oriented Programming, Object Oriented Programming Concepts, Benefits of Object oriented programming, Object Oriented Languages.	2
2	Objects and Classes classification, Defining Classes, Encapsulation, Instantiating Objects, Member Functions, Accessibility labels, Static Members.	5
3	Constructors and Destructors Purpose of Constructors, Default Constructor, Parameterized Constructors, Copy Constructor, Destructor, Memory Management	3
4	Inheritance Concept of Reusability, Types of Inheritance, Single and Multiple Inheritance, Multilevel Inheritance.	3

5	Operator Overloading Function and Operator Overloading, Overloading Unary and Binary Operators.	3
6	Polymorphism and Virtual Function Abstract Class, Function Overriding, Dynamic Binding, Pure Virtual Functions.	3
7	Streams and Files Stream Classes, Types of I/O, Formatting Outputs, File Pointers, Buffer.	3
8	Templates and STL Function and Class Templates, Use of Templates, Standard Template Library.	3
9	Exception Handling Exceptions in C++ Programs, Try and Catch Expressions, Exceptions with arguments.	3
Total Lectures		**28**

Suggested Text Book(s):

1. Lafore R., Object oriented programming in C++, Waite Group
2. Stroustrap B., The C++ Programming Language, Addison Wesley
3. Bruce Eckel, Thinking in C++

Evaluation Scheme:

S No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 hour.	Syllabus covered upto Test-1
2	T-2	25	1.5 hours	Syllabus covered upto Test-2
3	T-3	35	2 hours	Syllabus covered upto Test-3
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) -10 Attendance - 5

Course Outcomes (COs) contribution to the Programmed Outcomes (POs)

Course outcomes	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	1	2	2	1	2	2	1	1	1	3	3	**1.75**
CO-2	1	1	3	1	3	3	3	1	2	1	1	3	**1.92**
CO-3	2	2	1	2	1	1	2	3	1	3	2	1	**1.75**
CO-4	1	3	3	3	3	3	1	1	2	1	2	1	**2**
Average	**1.5**	**1.75**	**2.25**	**2**	**2**	**2.25**	**2**	**1.5**	**1.5**	**1.5**	**2**	**2**	

Introduction to C++ Programming Lab

COURSE CODE: 19B1WCI773
COURSE CREDITS: 1
CORE/ELECTIVE: OPEN
ELECTIVE **L-T-P:** 0-0-2

Pre-requisite: Introduction to C programming

Course Objectives:

The object oriented programming paradigm is one of the popular programming paradigms of today. Due to its characteristics object orientation has added new dimensions in the software development process. In this course concept of Object Oriented Programming (OOP) is introduced and for this purpose C++ programming language is being used. C++ a very powerful general purpose programming language, which supports object oriented programming paradigm. This course covers basics of C++ programming language which includes data types, variables, operators, and array and pointers. Also, object oriented features such as class and objects, inheritance, polymorphism are covered in this course. Finally exceptions handling, I/O operations and STL are explained.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	Learn the concepts of an Object-Oriented Programming	Familiarity
CO-2	Learn to define class, objects, object members, class members, data members, constructors and destructors	Usage
CO-3	Learn the concepts of Inheritance and Polymorphism in C++	Usage
CO-4	Learn the advanced features of C++, such as file handling, templates, and exception handling	Usage

List of Experiments

S No	Description	Hours
1	Design and implement a class using C++ that keeps the basic information about an account in a bank (the basic information must include account number and balance). The class should have a constructor that is used to create a new account object. The class should also have a function that transfers a requested amount from an account (identified by an account number) to another account.	**2**
2	Design and implement a class BCD using C++. The BCD class accepts an integer value (maximum five decimal digit input) using an input function of the class and which separates the digits and then stores them in a data member array of the class. For example, if input was 123 then it will be stored in data member array as num (0) = 3, num (1) = 2; and num (2) =1; similarly if input number was 2345 then it will be stored as num (0) = 5, num (1) = 4, num (2) = 3 and num (3) = 2. The class has another member function that calculates the reverse of integer value and prints it. For example, the input value 2345 will be reversed and printed as 5432.	**2**

3	Design and implement a class "circle". You may assume that the circle may be represented by the centre and the radius. The class should have functions to calculate the area of the circle and at least one overloaded operator function (you may overload << or >> or any other operator).	**2**
4	Define a class Employees having data members as: employee number, name, date of birth (dd-mm-yyyy), rank, and salary. When an employee is first recruited then all these are given values of 0. Upon confirmation, the actual values of these are entered for the employee. The employee's rank can be incremented by 1 and when this happens an employee gets an increment of 25%.	**2**
5	Students are registered in a University. When students are created then they are given default values (zeroes or blanks) for roll_number, department, year, and semester of study. At registration time, the values of these attributes of student are updated with the proper values. Students can be promoted and their departments can be changed.	**2**
6	Define two classes Distance1 and Distance2. Distance1 stores distance in miles and Distance2 in kmeters & meters. Write a program that reads values of the class objects and adds one object of Distance1 with the object of Distance2 class. The display should be in the format of miles or kmeters & meters depending on the type of object (Distance1 or Distance2) being used to invoke the function. (Hint: Make use of friend function).	**2**
7	Mid-Semester Practical Examination	**2**
8	Imagine a publishing company that markets both books and audio-cassette version of its works. Create a class Publication that stores the title (a string) and price (type float) of a publication. From this class derive two classes: Book, which adds a page count and Tape, which adds playing time in minutes. These classes should have getdata() function to get its data from the user and the putdata() function to display its data. Write a main() program to test the book and tape classes by creating instances of them, asking the user to fill in their data with getdata() and displaying the data with putdata().	**2**
9	Define a class Shape with two pure virtual functions as enterData() and displayArea(). Now, define a classes Rectangle and Circle that inherit the Shape class. Both the classes override and define the pure virtual functions. In the main() method, illustrate the concept of dynamic binding.	**2**
10	Define a class Directory with members: name and phone number. Use the class object to store each set of data into a text file "phone.txt". The names contain only one word and the names and telephone numbers are separated by white spaces. Write a program to read the file and output the list in two columns, such as: John 23456 Denvar 9876 …… ……	**2**
11	Create a class named Student. Data members include the student's roll number, first name, last name, class and the program of study. Member functions include enter() and display() to enter and display the record of the	**2**

	student. In the main() method, write multiple objects of this class into the file stud.txt. There should be an option to search a student's record on the basis of his/her roll number and delete it from the file.	
12	A programmer wants to manipulate arrays. Two arrays are equal if (a) they have the same dimension, (b) are of the same size, and (c) contain identical values in their corresponding elements. Comparison is done using the operator '= =' which returns true or false. Also, arrays can be copied to one another using the operator '='. Define a template function to sort an array of elements of int type, float type, and string type.	**2**
13	Define an exception called "NoMatchException" that is thrown when a string is not equal to "India". Write a program that uses this exception.	**2**
14	End-Semester Practical Examination	**2**
	Total Lab hours	**28**

Evaluation Scheme:

S No	Exam	Coverage/Scope of Examination	Marks
1	Mid Term Test	Viva and Written Exam	20
2	End Term Test	Viva and Written Exam	20
3	Lab Records		15
4	Teacher Assessment	(Quality and quantity of experiment performed, learning laboratory skills)	30
5	Attendance and discipline in lab		15
6	Total		100

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	1	2	2	1	2	2	1	1	1	3	3	**1.75**
CO-2	1	1	3	1	3	3	3	1	2	1	1	3	**1.92**
CO-3	2	2	1	2	1	1	2	3	1	3	2	1	**1.75**
CO-4	1	3	3	3	3	3	1	1	2	1	2	1	**2**
Average	**1.5**	**1.75**	**2.25**	**2**	**2**	**2.25**	**2**	**1.5**	**1.5**	**1.5**	**2**	**2**	

Manufacturing Process and Industrial Products

COURSE CODE :

COURSE CREDITS : 03

: 3-0-0

CORE/ELECTIVE : Elective

Pre-requisite: None

Course Objectives:

The objective of this course is to learn the advanced technologies in manufacturing of therapeutic and plant-based biotechnological products which coupled with the industrial-scale knowledge of biotechnological production and latest downstream process scheme and techniques.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Manufacturing technologies for Therapeutic and Pharmaceutical compounds	Familiarity and Usage
CO-2	Manufacturing of plant-based bioactive /secondary compounds	Familiarity and Usage
CO-3	Manufacturing of Alcoholic beverages	Familiarity and Usage
CO-4	Manufacturing Biotechnological products: Industrial scale approaches	Familiarity and Usage
CO-5	Manufacturing technologies for Biotechnological products: Advanced DSP Approaches	Familiarity and Usage

Course Contents:

Unit	Contents	Lectures required
1	**Manufacturing technologies for Therapeutic and Pharmaceutical compounds** Microbial production Technology of Therapeutic enzymes: L-asparaginase, L-glutaminase, Pencillin acylase and nattokinases Biocatalysts towards production of pharmaceutically active racemic mixtures	12
2	**Manufacturing of plant-based bioactive**	7

	/secondary compounds Plant-Associated Microorganisms (Endophytes) as a New Source of Bioactive Natural Products Biotechnological Methods for Selection of High-Yielding Cell Lines and Production of Secondary Metabolites in Medicinal Plants	
3	**Manufacturing of Alcoholic beverages** Wine Biotechnology: Manufacturing and technological considerations of White, Red, Sparkling, Fortified, and Cider	5
4	**Manufacturing Biotechnological products: Industrial scale approaches** Industrial-Scale Fermentation Scale-Down: Simulating Large-Scale Cultures in the Laboratory	9
5	**Manufacturing technologies for Biotechnological products: Advanced DSP Approaches** Schematic approaches for the Isolation and Purification of Fermentation Products Advances in Biochromatography: Dye-ligand Affinity chromatography, Immobilized metal-ion affinity chromatography (IMAC) and Immobilized histidine ligand affinity chromatography	9
	Total Lectures	42

Suggested Text Book(s):

- Current Developments in Biotechnology and Bioengineering: Production, Isolation and Purification of Industrial Products by Ashok Pandey, Sangeeta Negi, Carlos Ricardo Soccol
- Medicinal Plant Biotechnology by Oliver Kayser and Wim J. Quax
- Current Developments in Biotechnology and Bioengineering: Food and Beverages Industry Edited by Ashok Pandey, Maria A´ngeles Sanroma´n, Guocheng Du, Carlos Ricardo Soccol, Claude-Gilles Dussap
- Industrial Biotechnology by Christoph Wittmann and James C. Liao
- Biochromatography: Theory and practice Edited by M.A.Vijayalakshmi
- Review and research articles from Science Direct, Springer, Wiley and PubMED publishers

Course outcomes	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12
CO-1	2	2	3	1	1	2	2	3	2	2	1	2
CO-2	1	2	2	2	2	1	-	2	2	2	1	3
CO-3	2	2	2	2	2	2	1	1	2	-	2	2
CO-4	2	3	2	1	2	1	-	1	3	2	-	2
CO-5	1	3	1	3	2	2	1	2	1	2	1	3

Modeling and Simulation and Computer Applications

COURSE CODE:
COURSE CREDITS: 3
CORE/ELECTIVE: ELECTIVE
L-T-P: 3-0-0

Pre-requisite: Engineering Mathematics; Basics of Computer Programming

Course Objectives:

1. To bridge the gap between physical problem and mathematical modeling.
2. To enable the solution of complicated mathematical problems through numerical techniques.
3. Realistic modelling and simulations that take into account precise geometry and material properties, realistic representations of physical and natural processes, and rational predictions.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Introduction to numerical methods for solving different mathematical problems with highest possible level of accuracy	Familiarity
CO-2	Use of numerical techniques to determine the solution of complicated engineering problems	Assessment
CO-3	Select the most appropriate solution scheme for modeling a system and use their engineering knowledge to thereby design the solution procedure and use this knowledge for the society.	Assessment
CO-4	Identify the problems in Civil Engineering which need simulation for their solution and obtain their solution.	Assessment

Course Contents:

Unit	Contents	Lectures required
1.	Introduction to Mathematical Modelling Methods: Errors and their sources; Taylor Series Expansion, Introduction to SCILAB, SCILAB Script	**2**
2.	Basic System Models; System Models of Combined Systems; Introduction to Dynamic Response and System Transfer Function	**4**
3.	Direct Solution of Linear Systems: Gauss Elimination Method; Gauss Jordan Method; Pivoting, Factorization, Cholesky Decomposition; Singularity; Banded Matrices and their storage; Iterative Solutions using SCILAB	**4**

4.	Direct Solution of Non-linear Systems: Newton Raphson iterations to find roots of a 1D nonlinear equation. Generalization to multiple dimensions. Newton Iterations, Quasi Newton iterations; Iterative Solution using SCILAB	**4**
5.	Curve fitting method, linear and non-linear fitting, Linear interpolation, Lagrange interpolation method, Newton Interpolation formula, practical examples using SCILAB	**4**
6.	Numerical differentiation, central difference methods, higher order derivatives, errors, practical examples using SCILAB	**6**
7.	Numerical integration, Simpson's 1/3 rule, Simpson's 3/8 rule, local and global error analysis, practical examples using SCILAB	**4**
8.	Eigenvalue problems, Heun's method, Euler's method, Runge Kutta Method, Gerschgorin disc theorem , Jacobi method, Practical examples using SCILAB	**6**
9.	Simulation Techniques, Random numbers, Monte Carlo Method, Importance of Sampling, Metropolis Algorithm, Heat- bath algorithm, practical examples using SCILAB	**8**
TOTAL		**42**

Suggested Textbook(s):

Simulation-Based Reliability Assessment for Structural Engineers(New Directions in Civil Engineering) by Mark Pavel, CRC press

Suggested Reference Book(s):

Numerical Methods by D. Dahlquist, and A. Bork, Dan Prentice-Hall.

Other useful resource(s): Link to NPTEL courses –

1. https://nptel.ac.in/courses/105/105/105105043/
2. https://nptel.ac.in/courses/112/107/112107214/
3. https://nptel.ac.in/courses/115/103/115103114/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Throughout the Semester	Assignment (4) – 10 Quizzes(2)-10 (Best Score) Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Modelling, Simulation and Computer Applications)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	2	1	2	2	1	0	2	2	3	3	**2.00**
CO-2	2	3	2	1	1	2	1	2	2	0	3	2	**1.75**
CO-3	1	3	1	2	3	0	1	3	1	2	1	3	**1.75**
CO-4	2	2	2	1	2	1	1	0	3	0	3	2	**1.58**
Average	**2.00**	**2.75**	**1.75**	**1.25**	**2.00**	**1.25**	**1.00**	**1.25**	**2.00**	**1.00**	**2.50**	**2.50**	

Object Oriented Technologies using Java

COURSE CODE:19B1WCI734

COURSE CREDITS: 2

ELECTIVE: OPEN ELECTIVE

: 2-0-0

Pre-requisite: Introduction to C Programming Course Objectives:

Today almost every branch of computer science is feeling presence of object- orientation. Object oriented technology is successfully incorporated in various fields of computer science. Since its arrival on the scene in 1995, the Java has been accepted as one of the primary programming language. This course is designed to give you exposure to basic concepts of object-oriented technology. This course will help in learning to write programs in Java using object-oriented paradigm. Approach in this course is to take Java as a language that is used as a primary tool in many different areas of programming work.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO1	Understanding the features and concepts of Object-Oriented Programming using Java	Familiarity
CO2	Defining classes, objects, constructors, methods in Java	Usage
CO3	Inheritance, Interfaces, and Polymorphism	Usage
CO4	Packages, Exception Handling, and Multithreading	Usage

Course Contents:

S No	Topics	Lectures required
1	Object-Oriented Concepts: Classes and Objects, Abstraction and Encapsulation, Inheritance, and Polymorphism.	2
2	Java Language Basics Introduction To Java, Basic Features, Java Virtual Machine Concepts, A Simple Java Program, Primitive Data Type And Variables, Java Keywords, Integer and Floating Point Data Type, Character and Boolean Types, Declaring and Initialization Variables, Java Operators.	3
3	Expressions, Statements and Arrays Expressions, Statements, Control Statements, Selection Statements, Iterative Statements, Jump Statements, Arrays.	2
4	Class and Objects Class Fundamentals, Creating objects, Assigning objectreference variables, Introducing Methods, Static methods, Constructors, Overloading constructors, This Keyword, Using Objects as Parameters, Argument passing, Returning objects, Method Overloading, Garbage Collection, The finalize () Method.	5
5	Strings and Characters Fundamentals of Characters and Strings, The String Class, String Operations, Data Conversion using valueOf() Methods, String Buffer Class and Methods.	2

6	Inheritance and Polymorphism Inheritance Basics, Access Control, Multilevel Inheritance, Method Overriding, Abstract Classes, Polymorphism, Final Keyword.	4
7	Packages and Interfaces Package, Defining Package, CLASSPATH, Package naming, Accessibility of Packages, Using Package Members, Interfaces, Implementing Interfaces, Interface and Abstract Classes, Extends and Implements Together.	3
8	Exceptions Handling Exception, Handling of Exception, Using try-catch, Catching Multiple Exceptions, Using finally clause, Types of Exceptions, Throwing Exceptions, Writing Exception Subclasses	3
9	Multithreaded Programming Multithreading: An Introduction, The Main Thread, Java Thread Model, Thread Priorities, Synchronization in Java, Inter-thread Communication.	4
	Total	**28**

Suggested Text Book(s):

1. Java 2: The Complete Reference, Fifth Edition -- by Herbert Schildt
2. Bruce Eckel, Thinking in Java

Evaluation Scheme:

S No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 hour.	Syllabus covered upto Test-1
2	T-2	25	1.5 hours	Syllabus covered upto Test-2
3	T-3	35	2 hours	Syllabus covered upto Test-3
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) -10 Attendance - 5

Course Outcomes (COs) contribution to the Programmed Outcomes (POs)

Course outcomes	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	1	2	2	1	2	2	1	1	1	3	3	**1.75**
CO-2	1	1	3	1	3	3	3	1	2	1	1	3	**1.92**
CO-3	2	2	1	2	1	1	2	3	1	3	2	1	**1.75**
CO-4	1	3	3	3	3	3	1	1	2	1	2	1	**2**
Average	**1.5**	**1.75**	**2.25**	**2**	**2**	**2.25**	**2**	**1.5**	**1.5**	**1.5**	**2**	**2**	

Object Oriented Technologies using Java Lab

COURSE CODE: 19B1WCI774
COURSE CREDITS: 1
CORE/ELECTIVE: OPEN
ELECTIVE **L-T-P:** 0-0-2
Pre-requisite: Introduction to C programming

Course Objectives:

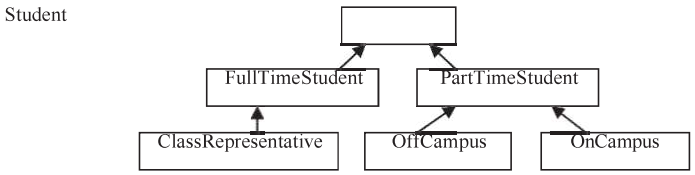
Today almost every branch of computer science is feeling presence of object- orientation. Object oriented technology is successfully incorporated in various fields of computer science. Since its arrival on the scene in 1995, the Java has been accepted as one of the primary programming language. This course is designed to give you exposure to basic concepts of object-oriented technology. This course will help in learning to write programs in Java using object-oriented paradigm. Approach in this course is to take Java as a language that is used as a primary tool in many different areas of programming work.

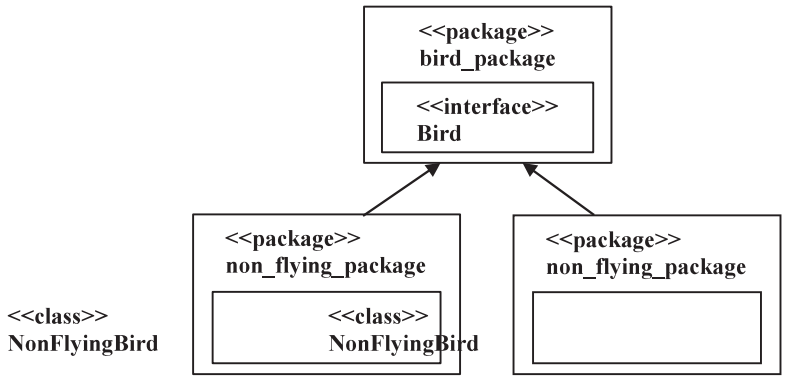
Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO1	Understanding the features and concepts of Object-Oriented Programming using Java	Familiarity
CO2	Defining classes, objects, constructors, methods in Java	Usage
CO3	Inheritance, Interfaces, and Polymorphism	Usage
CO4	Packages, Exception Handling, and Multithreading	Usage

List of Experiments

S No	Description	Hours
1	i. Write a Java program to check if a number is a palindrome in Java. ii. Write a Java program to print following structure. * *** ***** *** *	**2**
2	Write a program in Java to print the Fibonacci series up to a given number? Write both iterative and recursive versions.	**2**
3	Define a class Queue in Java with methods to insert and delete the data (int type) from the queue. The queue must be implemented using array.	**2**
4	Define a class LinkedList in Java with members data of integer type and a reference next of LinkedList type. Define methods to insert and display the elements of the linked list.	**2**

5	Implement a singleton class. A class whose number of instances that can be instantiated is limited to one is called a singleton class. (Hint: make use of static members).	**2**
6	Write a Java program that accepts two strings S1 and S2 as input. The program should check if either of the input strings is a substring of the other and give appropriate message as output.	**2**
7	Mid-Semester Practical Examination	**2**
8	Design and implement the following class hierarchy using Java. 	**2**
9	Define a class named Television in Java that has data members to hold the model number of a television, the screen size in inches, and the price. The class has methods to enter and display the details of the television. The class throws an exception "TelevisionException under the following conditions: • If more than 4 digits are entered for the model number • If the screen size is smaller than 12 inches or greater than 70 inches. • If the price is negative or greater than Rs 50,000.	**2**
10	You may include additional data members in the classes. The class Programme is defined inside the package pack1.pack2, whereas classes FullTime and PartTime are defined inside the package pack1. You should include at least one constructor in each class. All the classes should have two methods as getProgrammeInfo() and printProgrammeInfo() to enter and display all the information of that object, respectively.	**2**
11	Define a class *First* inside a package pack1 with an integer data member *i* and methods to enter and display the value of *i*. Define another class inside a package pack2, which is a sub package of pack1. The class *Second* has a float type data member *f* and methods to enter and display the value of *f*. Now, import both of the above classes and instantiate their objects in the main method. Thereafter, call the methods of both the classes.	**2**
12	Realize the following class diagram using Java.	**2**

		
13	Write a program for generating two threads using Runnable interface. One thread is used for printing the numbers (1 to 26) and the other for printing alphabets (A to Z). Which of the two threads will be executed first (assuming that both of the threads are set to the same priority)?	**2**
14	End-Semester Practical Examination	**2**
	Total Lab hours	**28**

Evaluation Scheme:

S No	Exam	Coverage/Scope of Examination	Marks
1	Mid Term Test	Viva and Written Exam	20
2	End Term Test	Viva and Written Exam	20
3	Lab Records		15
4	Teacher Assessment	(Quality and quantity of experiment performed, learning laboratory skills)	30
5	Attendance and discipline in lab		15
6	Total		100

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	1	2	2	1	2	2	1	1	1	3	3	**1.75**
CO-2	1	1	3	1	3	3	3	1	2	1	1	3	**1.92**
CO-3	2	2	1	2	1	1	2	3	1	3	2	1	**1.75**
CO-4	1	3	3	3	3	3	1	1	2	1	2	1	**2**
Average	**1.5**	**1.75**	**2.25**	**2**	**2**	**2.25**	**2**	**1.5**	**1.5**	**1.5**	**2**	**2**	

PhD Course

Reconfigurable Computing

COURSE CODE: 19P1WEC101

COURSE CREDITS: 3

CORE/ELECTIVE: PhD

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives

Students will gain fundamental knowledge and understanding of principles and practice in reconfigurable architecture and computing through class lectures and discussions, and reading assignments.

Course Outcomes :

S.No.	Course Outcomes	Level of Attainment
CO-1	Understand the concept of reconfigurable computing and FPGA architectures.	Familiarity
CO-2	Understand and explore the various FPGA computing platforms in terms of design tools.	Familiarity
CO-3	The student will be able to formulate the specialized arithmetic circuits and powerful techniques like pipelining and unfolding	Assessment
CO-4	Analyze the coarse-grained and fine grain configurability for performance enhancement using multi-FPGA systems.	Assessment
CO-5	To be able to create new designs and analyze advanced techniques such as fault tolerance and partial reconfiguration.	Usage
CO-6	Design, analyze and apply reconfigurable computing in various applications for optimization.	Usage

Course Contents :

S. No.	Contents	Lecture Required
1.	Introduction: Test Process and Test Economics, Functional vs Structural Testing Defects, Errors, Faults and Fault Modelling (mainly stuck at fault modelling), Fault Equivalence, Fault Dominance, Fault Collapsing and Checkpoint Theorem.	8

2.	FPGA Architectures and Algorithms of Reconfigurable Computing : General overview of computing models, Basic RC concepts, Performance, power, size, and other metrics, RC devices and architecture – fine grained and coarse grained, integration into traditional systems, FPGA computing platforms, Design tools and languages: HDLs, Synthesis, PAR, HLL and HLS, RC application development, domains and case studies, Special topics in RC: Middleware, Fault tolerance, Partial reconfiguration, device characterization.	8
3.	Implementing Applications with FPGAs : Strengths and Weaknesses of FPGAs, Time to Market, Development Time, Power Consumption, Debug and Verification, FPGAs and Microprocessors, Application Characteristics and Performance, Computational Characteristics and Performance, I/O and Performance, General Implementation Strategies for FPGA-based Systems, Configure-once, Runtime Reconfiguration, Summary of Implementation Issues, Implementing Arithmetic in FPGAs, Fixed-point Number Representation and Arithmetic, Floating-point Arithmetic, Block Floating Point, Constant Folding and Data-oriented Specialization	9
4.	Defect and Fault Tolerance : Defects and Faults, Defect Tolerance, Substitutable Resources, Yield, Defect Tolerance through Sparing, Defect Tolerance with Matching, Transient Fault Tolerance, Feedforward Correction, Rollback Error Recovery, Lifetime Defects, Detection, Repair, Configuration Upsets,	8
5.	Reconfigurable Computing and Nanoscale Architecture Trends in Lithographic Scaling, Bottom-up Technology, Nanowires, Nanowire Assembly, Crosspoints, Challenges, Nanowire Circuits, Wired-OR Diode Logic Array , Restoration, Statistical Assembly, nanoPLA Architecture, Basic Logic Block, Interconnect Architecture, Memories, Defect Tolerance, Design Mapping, Density Benefits, Nanoscale Design Alternatives, Imprint Lithography, Interfacing	9
	Total	42

Suggested Text Book (s) :

1. N. Nedjah , C. Wang, Reconfigurable and Adaptive Computing: Theory and Applications, Chapman and Hall/CRC, 1st Ed., 2018.
2. S. Hauck and A. DeHon, Reconfigurable Computing: The Theory and Practice of FPGA-Based Computation, Elsevier, 1st Ed., 2008.
3. M. B. Gokhale and P.S. Graham, Reconfigurable Computing: Accelerating Computation with Field Programmable Gate Arrays, Springer, 1st Ed., 2005.

Suggested Reference Book(s):

1. R. Cofer and B.F. Harding, Rapid System Prototyping with FPGAs: Accelerating the Design Process, Newnes, 1st Ed., 2005
2. C. Maxfield, The Design Warrior's Guide to FPGAs, Newnes, 1st Ed., 2004
3. C. Bobda, Introduction to Reconfigurable Computing: Architectures, Algorithms and Applications, Springer, 1st Ed., 2007.
4. P. Lysaght and W. Rosenstiel, New Algorithms, Architectures and Applications for Reconfigurable Computing, Springer, 1st Ed., 2005.

Other useful resource(s):

1. http://www.secs.oakland.edu/~llamocca/Fall2015_ece495.html

Software Defined Network

COURSE CODE: 19B1WCI739

COURSE CREDITS: 3

CORE/ELECTIVE: OPEN

ELECTIVE **L-T-P:** 3-0-0

Pre-requisite: None

Course Objectives:

- To understand the fundamentals of software defined networks.
- To understand the separation of the data plane and the control plane.
- To study about the SDN Programming.
- To study about the various applications of SDN

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Analyze the evolution of software defined networks	Familiarity
CO-2	Express the various components of SDN and their uses	Assessment
CO-3	Explain the use of SDN in the current networking scenario	Assessment
CO-4	Design and develop various applications of SDN	Usage

Course Contents:

Unit	Contents	Lectures required
1	**Introduction:** Basic Packet-Switching Terminology, Historical Background, The Modern Data Center, Traditional Switch Architecture, Autonomous and Dynamic Forwarding Tables. Open Source and Technological Shifts	7
2	**Why SDN?:** Evolution of Switches and Control Planes, Cost, SDN Implications for Research and Innovation, Data Center Innovation, Data Center Needs	7
3	**The Genesis of SDN :**The Evolution of Networking Technology, Forerunners of SDN, Software Defined Networking is Born., Sustaining SDN Interoperability, Open Source Contributions. Legacy Mechanisms Evolve Toward SDN, Network Virtualization	7
4	**How SDN Works:** Fundamental Characteristics of SDN, SDN Operation, SDN Devices, SDN Controller, SDN Applications, Alternate SDN Methods.	7
5	**The Open Flow Specification:** Open Flow Overview, Open Flow 1.0 and Open Flow Basics, Open Flow Limitations.	7

6	**Alternative Definitions of SDN and SDN in Other Environments:** SDN via APIs, SDN via Hypervisor-Based Overlays, SDN in Data Center, Wide Area Networks, Campus Networks, Hospitality Networks, Mobile Networks	7
	Total lectures	**42**

Suggested Text Book(s):

- Paul Goransson and Chuck Black, Software Defined Networks: A Comprehensive Appro
- Thomas D. Nadeau, Ken Gray, SDN: Software Defined Networks, O'Reilly Media, 2013.

Suggested Reference Book(s):

- Siamak Azodolmolky, Software Defined Networking with Open Flow, Packet Publishing, 2013.
- Vivek Tiwari, SDN and Open Flow for Beginnersll, Amazon Digital Services, Inc., 2013.
- Fei Hu, Editor, Network Innovation through Open Flow and SDN: Principles and Design, CRC Press, 2014.

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programmed Outcomes (POs)

Course Outcomes	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	1	2	2	2	3	1	1	1	1	2	2	3	**1.75**
CO-2	3	3	2	2	2	2	2	1	2	2	1	2	**2**
CO-3	3	1	2	1	2	2	2	2	2	3	1	1	**1.83**
CO-4	3	3	2	2	2	2	1	2	1	2	2	1	**1.91**
Average	**2.5**	**2.25**	**2**	**1.75**	**2.25**	**1.75**	**1.5**	**1.5**	**1.5**	**2.25**	**1.5**	**1.75**	

Introduction to Statistical Learning

COURSE CODE: **19B1WCI740**

COURSE CREDITS: 3

CORE/ELECTIVE: OPEN

ELECTIVE **L-T-P:** 3-0-0

Pre-requisite: Basics of programming and mathematics.

Course Objectives:

- To understand the fundamentals of statistical learning and, analyzing regression and classification.
- To understand and analyze pre-processing data and model selection.
- To understand and analyze non-linear and tree based regression.
- To understand and analyze Support Vector Classifier and Machines, and unsupervised learning.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Understanding statistical learning and, analyzing regression and classification.	Familiarity and usage
CO-2	Analyzing resampling, model selection and regularization.	Usage
CO-3	Analyzing non-linear and tree based regression.	Usage
CO-4	Analyzing Support Vector Machines and unsupervised learning	Usage

Course Contents:

Unit	Contents	Lectures required
1	**Introduction to statistical learning:** Prediction accuracy, Model interpretability, Supervised and Unsupervised learning, Assessing model accuracy	6
2	**Regression and Classification:** Regression- Linear, MultiLinear and kNN, Classification-Logistic regression, Linear and quadratic discriminant analysis, and kNN	8
3	**Resampling, Model Selection and Regularization:** Cross- validation, the bootstrap, Subset selection, Shrinkage methods, Dimension reduction methods, considerations in high dimension	8
4	**Non-linear Regression:** Polynomial regression, Step functions, Regression splines, Smoothing splines, Local regression, Generalized additive methods, **Tree Based Regression:** the basics of decision trees, Bagging, Random forest and Boosting,	10
5	**Support Vector Machines:** Maximal margin classifier, Support Vector Classifier and Support Vector Machines, **Unsupervised Learning:** The challenges, Principal Component Analysis, Clustering methods	10
	Total lectures	42

Approved in Academic Council held on 28 July 2021

Suggested Text Book(s):

- Gareth James, Daneila Witten, Trevor Hastie and Robert Tibshirani, "An Introduction to Statistical Learning with Applications in R", Springer, 8th Printing, 2017.

Suggested Reference Book(s):

- Hastie, Tibshirani and Friedman, "The elements of statistical learning", 2nd edition, Springer, 2009.
- Sanjeev Kulkarni and Gilbert Harman, " An elementary introduction to statistical learning theory, Wiley, 2011.
- Fernandes de Mello, Rodrigo et. al., " Machine Learning – A practical approach on the statistical learning theory", Springer, 2018.

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programmed Outcomes (POs)

Course Outcomes	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	3	3	3	3	1	1	2	1	3	2	**2.33**
CO-2	3	3	3	3	3	3	2	1	2	1	3	2	**2.42**
CO-3	3	3	3	3	3	3	2	1	2	1	3	2	**1.42**
CO-4	3	3	3	3	3	3	1	1	2	1	3	2	**2.33**
Average	**3**	**3**	**3**	**3**	**3**	**3**	**1.5**	**1**	**3**	**1**	**3**	**3**	

Principles of Distributed Database Systems

COURSE CODE: 19B1WCI838

COURSE CREDITS: 3

CORE/ELECTIVE: OPEN

ELECTIVE **L-T-P:** 3-0-0

Pre-requisite: Database management Systems

Course Objectives:

To introduce the fundamental concepts and design issues of managing large volume of shared data in distributed environment, and to provide insight into related research problems.

- To understand the fundamentals of Distributed Database Systems.
- To understand the various database designing processes.
- To study about the query processing and query optimization in a distributed environments.
- To study about the various applications of distributed databases.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Understand the fundamentals of Distributed Database Systems (DDBMS), including its design and architecture	Familiarity
CO-2	Understand the concept of data integration design process	Assessment
CO-3	Gain skill about query processing & optimization in distributes environment	Assessment
CO-4	Explain the use of Distributed database system in real life applications	Usage
CO-5	Implement applications/tools in order to utilize DDBMS applications.	Usage

Course Contents:

Unit	Contents	Lectures required
1	**Introduction:** Distributed Data Processing, What is a Distributed Database System? Data Delivery Alternatives, Promises of DDBSs, Complications Introduced by Distribution, Design Issues, Distributed DBMS Architecture,	4
2	**Distributed Database Design:** Top-Down Design Process, Distribution Design Issues, Fragmentation, Allocation, Data Directory	7
3	**Database Integration:** Bottom-Up Design Methodology, Schema Matching, Schema Integration, Schema Mapping, Data Cleaning	7
4	**Overview of Query Processing:** Query Processing Problem, Objectives of Query Processing, Complexity of Relational Algebra Operations, Characterization of Query Processors, Layers of Query Processing, Query Decomposition, Localization of Distributed data	6

5	**Optimization of Distributed Queries:** Query Optimization, Centralized Query Optimization, Join Ordering in Distributed Queries, Distributed Query Optimization	6
6	**Multidatabase Query Processing:** Issues in Multidatabase Query Processing, Multidatabase Query Processing Architecture, Query Rewriting Using Views, Query Optimization and Execution, Query Translation and Execution	6
7	**Dataspace System:** Introduction, Pay-as-you-go data integration, Design issues, Data modeling, Query processing and answering, Entity resolution, Users feedback in Dataspace System, Indexing dataspaces, Source Discovery	6
	Total lectures	**42**

Suggested Text Book(s):

- Principles of Distributed Database Systems, M. Tamer Ozsu, Patrick Valduriez , Springer, 2011, ISBN 978-1-4419-8833-1.
- Distributed Database Management Systems- A Practical Approach, Saeed K Rahimi, Frank S Haug, Wiley Publication, 2010, ISBN 978-0-470-40745-5

Suggested Reference Book(s):

1. Distributed Database Mangement Systems, Rahimi & Haug, Wiley
2. Distributed Database Systems, Chanda Ray, Pearson Publication
3. Additional research papers from the literature may be assigned as reading material.

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) – 10 Quizzes (2) - 10 Attendance – 5

Course Outcomes (COs) contribution to the Programmed Outcomes (Pos)

Course outcomes (Software Defined Network)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	3	2	2	3	2	2	2	3	1	3	**2.4**
CO-2	3	3	3	2	3	2	3	2	2	3	1	3	**2.5**
CO-3	3	3	3	2	2	3	1	2	3	3	1	3	**2.4**
CO-4	3	3	3	2	3	3	2	2	3	3	1	3	**2.6**
CO-5	3	3	3	2	3	3	2	2	3	3	1	3	**2.6**
Average	**3**	**3**	**3**	**2**	**2.6**	**2.8**	**2**	**2**	**2.6**	**3**	**1**	**3**	

Approved in Academic Council held on 28 July 2021

Foundations of Block Chain

Course Code: 19B1WCI839
Course Credit: 3-0-0

Course Pre-requisites (if any): Some programming experience (at least one year suggested). Potential students will need to pass a brief programming assessment for enrollment in the course.

Course Objectives:

S No	Course Outcomes (Block Chain Technologies) 18B1WCI836	Level of Attainment
CO-1	Explain how bitcoin works, from when a transaction is created to when it is considered part of the blockchain	Familiarity
CO-2	Thoroughly explain private and public keys as well as addresses and how exactly they are constructed and used	Familiarity
CO-3	Expose students to the different kinds of forking and explain the Bitcoin's network mechanisms for maintaining and upgrading	Assessment
CO-4	Decompose a blockchain system's fundamental components, how they fit together and examine a modular blockchain system in more detail	Assessment
CO-5	Detailed understanding of naïve Attacks and Trustless Networks of block chain	Assessment
CO-6	Provide a thorough understanding of smart contracts, their technical capabilities, practical applications, limitations and security constraints they operate within	Usage
CO-7	Explain to students both fundamental and implied differences between Ethereum and Bitcoin protocol by covering historical, conceptual and architectural distinctions	Assessment

Detailed Course Contents:

Module	Contents	Lectures required
Module-1	**The story of a transaction** a) From Transactions to Blocks b) Blocks and Distributed Consensus c) Basic interaction with a Bitcoin node	**2**
Module-2	**Keys and Addresses** a) Basic cryptography b) From private keys to addresses	**2**
Module-3	**The Bitcoin Script language** a) Introduction to the Bitcoin Script language b) Script writing and execution c) Advanced scripting	**8**
	d) Tools and libraries to access Bitcoin's API and scripting capabilities **Blockchain deployment** a) Mining and forking b) Upgrading the network c) Related BIPs	

	d) Segregated Witness (SegWit)	
Module-4	**Blockchain architectures** a) Abstract Architecture b) Ways to dive deeper c) Introduction to major blockchain platforms	**6**
Module-5	**Comparing Bitcoin and Ethereum** a) Historical comparison b) Conceptual distinction between a payment system and a decentralized applications platform *c)* Differences in their architectures from *security-first aspect to a rich feature set* d) Future roadmap for them, following their own paths with probable interconnections	**8**
Module-6	**Development environment** a) Multitude of clients in Ethereum b) Production and test networks in Ethereum *c) Public, private and development deployments* **Contract code walk-through** a) Demonstration of smart contract b) Introduction to Solidity c) Contract lifecycle	**8**
Module-7	**Solidity in depth** a) Building blocks b) Popular contracts already in deployment **Considerations for production deployment** a) Quality of decentralized applications b) Code patterns *c) Security* d) Other smart contract platforms e) Discussion of future prospects	**8**
	TOTAL LECTURES	**42**

Suggested Text Book(s):

- Mastering Bitcoin, Andreas Antonopoulos, O'Reilly Publishing, 2014, ISBN: 978- 0691171692.
- Bitcoin: A Peer-to-Peer Electronic Cash System, Satoshi Nakamoto, Online 2009 https://bitcoin.org/bitcoin.pdf
- Vitalik Buterin, Ethereum White Paper, Online, 2017, https://github.com/ethereum/ wiki/wiki/ White- Paper

Suggested Reference Book(s):

- Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction, A. Narayanan, J.
- Bonneau, E. Felten, A. Miller, S. Goldfeder, Princeton University Press, 2016, ISBN: 978-0691171692
- The Science of the Blockchain, Roger Wattenhofer, CreateSpace Independent Publishing Platform, 2016, ISBN: 978-1522751830

- Ethereum Programming, Alex Leverington, Packt Publishing Limited, 2017, ISBN: 978- 1786463715

Other useful resource(s):

- Bitcoin Protocol Specifications (https://en.bitcoin.it/wiki/Protocol_specification)
- Bitcoin transaction Scripting (https://en.bitcoin.it/wiki/Script)
- Majority is not Enough: Bitcoin Mining is Vulnerable (http://arxiv.org/abs/1311.0243)
- Two Bitcoins at the Price of One? Double-Spending Attacks on Fast Payments in Bitcoin (http://eprint.iacr.org/2012/248.pdf)
- Ethereum documentation (http://www.ethdocs.org/en/latest)
- Solidity documentation ((https://solidity.readthedocs.io/en/develop))
- https://sites.google.com/site/blockchaintutorial/blockchain-course-content

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) – 10 Quizzes (2) - 10 Attendance – 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Weightage
CO-1	3	2	3	2	2	3	2	3	2	2	3	3	83
CO-2	3	2	3	2	2	3	3	2	2	3	3	3	86
CO-3	2	2	2	2	2	3	3	3	2	2	3	3	81
CO-4	3	2	3	2	3	2	2	3	3	3	2	2	83
CO-5	3	2	2	2	3	2	2	2	2	3	3	3	81
CO-6	2	3	3	3	3	2	3	2	2	3	3	2	86
CO-7	2	2	2	2	2	3	3	3	2	2	3	3	81
Weightage	86	71	86	71	81	86	86	86	71	86	95	90	

Computational Biology

COURSE CODE: 19B1WCI840

COURSE CREDITS: 3

ELECTIVE: OPEN

ELECTIVE **L-T-P:** 3-0-0

Pre-requisite: None

Course Objectives:

- To understand the fundamentals of Computational Molecular Biology.
- To understand the computational methods for biological sequence analysis.
- To study about the dynamic programming for sequence alignments, methods for genomics and structural bioinformatics.
- To study about the various applications of computer science techniques in computational biology.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Fundamentals of Computational Molecular Biology	Familiarity
CO-2	Express the use of computational methods for biological sequence analysis	Assessment
CO-3	Explain the use of sequence alignments, methods for genomics and structural bioinformatics	Assessment
CO-4	Applications of computer science techniques in computational biology	Usage

Course Contents:

Unit	Contents	Lectures required
1	**Introduction:** Basic knowledge of molecular biology including DNA, RNA, Proteins and Genetic code systems. Biological sequences types and data. Computers in biology, medicine and healthcare.	5
2	**Biological Databases:** Evolution of biological databases. Collection, storage and analysis of biological data through biological databases. Sequence formats and storage, Access databases, limitations of existing databases.	4
3	**Sequence Alignment and Analysis:** Local alignment, Global alignment, Scoring matrices - PAM, BLOSUM, Gaps and penalties, Dot plots. Dynamic programming approach: Needleman and Wunsch Algorithm, Smith and Waterman Algorithm, Hidden Markov Model: Viterbi Algorithm. Heuristic approach: BLAST, FASTA. Building Profiles, Profile based functional identification.	7
	Computational Genomics: Introduction to Next Generation Sequencing	

4	technologies. Annotations through Functional and comparative genomics approaches, Human genome project. GWAS, ENCODE, HUGO projects. Personalized and precision medicines. **Software tools in Biology:** Visualization tools including Artemis and Vista for genome comparison. Applications of Grid computing in Biology. Compute Clusters and nature of problems dealt with them.	**10**
5	**Algorithms in Computational Biology:** Whole Genome Assembly and challenges, Fragment assembly algorithms, semi- global alignment, exon chaining and spliced algorithms, brute force, median string and other motif finding algorithms. Recent algorithms for MSA.	**6**
6	**Chemoinformatics:** Introduction, representing 2D & 3D structures, 2D chemical database applications & molecular descriptors and their classifications, database searching and applications in computer aided drug design.	**5**
7	**Quantitative structure activity relationship (QSAR)**: QSAR methodology, biological and physicochemical parameters, feature selection (PLS, PCA, MLR, etc.), model building and validation, QSAR applications in drug design, Quantitative structure-property relationships (QSPR), CoMFA, 3D and nD-QSAR methods.	**5**
	Total lectures	**42**

Suggested Text and Reference Book(s):

1. Dan E. Krane and Michael L. Raymer, 'Fundamental concepts of Bioinformatics', Pearson Education (low Priced Edition).
2. Claverie & Notredame, 'Bioinformatics - A Beginners Guide', Wiley- Dreamtech India Pvt Ltd.
3. J. Pevnezer, 'Bioinformatics and functional genomics', John Wiley.
4. David Mount, Bioinformatics: sequence and Genome Analysis, Latest Edition. Cold Spring Harbour Labortory Press.
5. Discovering Genomics, Proteomics and bioinformatics, 2/E by A. Malcolm Campbell and Laurie J.Heyer, Publisher:Benjamin Cummings.
6. ICRF handbook of genome analysis, by NK Spurr, BD Young, SP Bryant. Volumes I & II. - Blackwell science publishers.
7. Isaac S. Kohane, Alvin T. Kho, Atul J. Butte Microarrays for an Integrative Genomics, MIT Press.
8. Philip E. Bourne, Jenny Gu, Structural Bioinformatics, Wiley Blackwell Publisher.

Evaluation Scheme:

S No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Approved in Academic Council held on 28 July 2021

Course Outcomes (COs) contribution to the Programmed Outcomes (POs)

Course Outcomes	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	1	2	2	2	3	1	1	1	1	2	2	3	**1.75**
CO-2	3	3	2	2	2	2	2	1	2	2	1	2	**2**
CO-3	3	1	2	1	2	2	2	2	2	3	1	1	**1.83**
CO-4	3	3	2	2	2	2	1	2	1	2	2	1	**1.91**
Average	**2.5**	**2.25**	**2**	**1.75**	**2.25**	**1.75**	**1.5**	**1.5**	**1.5**	**2.25**	**1.5**	**1.75**	

Approved in Academic Council held on 28 July 2021

Multimedia Systems and Applications

COURSE CODE: 19B1WCI843

COURSE CREDITS: 3

CORE/ELECTIVE: OPEN ELECTIVE

: 3-0-0

Pre-requisites: Computer Networks, Operating Systems, Data Structure, Java Programming, Linear Algebra, Web Technology (Those who are simultaneously registered in some of these courses can also take this course.)

Course Objectives:

- fundamentals of multimedia systems
- basic concepts related to multimedia communication.
- the evolution, latest trends, and state-of-the-art in multimedia technology, standards, and applications

  Overall, the aim of the course would be to cover all aspects related to multimedia systems and applications ranging from basic concepts and fundamentals to more advanced discussions on the state-of-the-art in this field..

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Demonstrate mastery of scripting in a multimedia development environment.	Familiarity
CO-2	Create multi-user multimedia applications.	Assessment
CO-3	Create an image/audio/video multimedia application.	Assessment
CO-4	Apply image-processing algorithms to multimedia content within a scripting environment.	Assessment
CO-5	Apply current standards and guidelines for multimedia application development and delivery	Usage

Course Contents:

Unit	Contents	Lectures required
1	**Introduction to Multimedia System and Processing** Introduction to Multimedia, Application Areas, Interdisciplinary Aspects of Multimedia, Multimedia Data representations, Multimedia Data Encoding (Audio, Image, Video and Animation),	6

2	**Multimedia Compression Basics** Concept of data compression in multimedia field, lossless techniques (Huffman Coding, Arithmetic and Lempel-Ziv Coding, Other Coding Techniques) and lossy compression techniques (Transform Coding & K-L Transforms, Discrete Cosine Transforms, and BTC), Multi-Resolution Analysis, and Still Image Compression Standards (JBIG and JPEG), Color image processing.	**12**
3	**Audio and Video Processing:** Basics of digital audio, quantization and transmission of Audio. Audio compression, Audio MPEG, Video Coding Standards (MPEG video coding, MPEG4, 7, and beyond).	**6**
4	**Media Server & Networks :** Media Server Architecture, Storage Management, Services, Protocols, Layers, Requirements to Services and Protocols, Layers of the ISO-OSI Model, ATM Networks, Traditional network protocols and their support for Multimedia, Traditional transport protocols and their support for Multimedia, New protocols for transport of multimedia	**6**
5	**Quality of Service & Multimedia Operating System** Requirements and Constraints, Quality of Services Concept, Resource Management, Establishment Phase (QoS Translation, QoS Scaling, QoS Routing, Admission Control), Run-time Phase of Multimedia Call, Process Management, Inter process Communication and Synchronization, Memory Management, Device Management.	**6**
6	**Multimedia Applications:** Case studies	**6**
	Total lectures	**42**

Suggested Text Book(s):

- Ralf Steinmetz, Klara Nahrstedt. Multimedia Systems, Springer, Springer International Edition, (Textbook)
- Fundamentals of Multimedia: Ze-Nian Li & Mark S. Drew, Pearson Prentice Hall, 2004

Suggested Reference Book(s):

- John. F. Koegel Buford. Multimedia Systems. Pearson Education.
- Robert Reinhardt and Joey Lott. Flash MX Action Script Programming. Wiley.
- James E. Shuman. Multimedia in Action. Cengage Learning.
- Khalid Shayood, Data Compression.

Other useful resource(s):

- IEEE Transactions on Multimedia Systems.
- Multimedia Systems (ACM Press)
- ACM SIGMM conference

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment		Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course Outcomes	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	3	2	2	3	2	2	2	3	1	3	**2.4**
CO-2	3	3	3	2	3	2	3	2	2	3	1	3	**2.5**
CO-3	3	3	3	2	2	3	1	2	3	3	1	3	**2.4**
CO-4	3	3	3	2	3	3	2	2	3	3	1	3	**2.6**
CO-5	3	3	3	2	3	3	2	2	3	3	1	3	**2.6**
Average	**3**	**3**	**3**	**2**	**2.6**	**2.8**	**2**	**2**	**2.6**	**3**	**1**	**3**	

Service Oriented Architecture

COURSE CODE: 19BIWCI842

COURSE CREDITS: 3

CORE/ELECTIVE: OPEN ELECTIVE

L-T-P: 3-0-0

Pre-requisites: Software Engineering, XML, JAVA, JAX-WS, JAX-RPC, ASP.NET

Course Objectives:

- To gain understanding of the basic principles of service orientation
- To learn service oriented analysis techniques
- To learn technology underlying the service design

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Basic understanding of software engineering	Familiarity
CO-2	To explore the various software oriented architectures and characteristics	Assessment
CO-3	To ana;lyze the various web services designed to perform many different roles.	Assessment
CO-4	To implement the various web services in XML, Java, ASP, etc.	Usage

Course Contents:

Unit	Contents	Lectures required
1	Basics of Software Engineering	**4**
2	Software Architecture	**6**
3	Roots of SOA–Characteristics of SOA-Comparing SOA to client-server and distributed internet architectures–Anatomy of SOA-How components in an SOA interrelate-Principles of service orientation	**6**
4	Web services–Service descriptions–Messaging with SOAP–Message exchange Patterns–Coordination–Atomic Transactions–Business activities–Orchestration–Choreography-Service layer abstraction–Application Service Layer–Business ServiceLayer–Orchestration Service Layer	**6**
5	Service oriented analysis–Business-centric SOA–Deriving business services-service modeling-Service Oriented Design–WSDL basics–SOAP basics–SOA composition guidelines–Entity-centric business	**6**

	service design–Application service design–Task-centric business service design	
6	SOA platform basics–SOA support in J2EE–Java API for XML-based web services (JAX-WS)-Java architecture for XML binding (JAXB)–Java API for XML Registries (JAXR)-Java API for XML based RPC (JAX-RPC)-Web Services Interoperability Technologies (WSIT)-SOA supportin .NET–Common Language Runtime-ASP.NET web forms–ASP.NET web services–Web Services Enhancements (WSE)	**8**
7	WS-BPEL basics–WS-Coordination overview-WS-Choreography, WS-Policy, WS-Security.	**6**
	Total lectures	**42**

Suggested Text Book(s):

- Applied SOA: service-oriented architecture and design strategies / Mike Rosen (2008) (ebook)
- Thomas Erl, "SOA Principles of Service Design "(The Prentice Hall Service-Oriented Computing Series from Thomas Erl), 2005.

Suggested Reference Book(s):

- Newcomer, "Understanding SOA with Web Services", Pearson Education, 2005.
- Sandeep Chatterjee, James Webber, "Developing Enterprise Web Services, An Architect's Guide", Pearson Education, 2005.

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment		Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	Average
CO-1	3	2	2	2	2	3	2	2	2	2	2	2	**2.2**
CO-2	3	3	3	2	2	3	3	2	2	2	1	1	**2.3**
CO-3	3	3	3	2	2	2	3	2	2	2	3	2	**2.4**
CO-4	3	3	2	2	2	2	2	2	3	2	2	3	**2.3**
Average	**3**	**2.8**	**2.5**	**2**	**2**	**2.5**	**2.5**	**2**	**2.3**	**2**	**2**	**2**	

Software Testing Methodologies

COURSE CODE: 19B1WCI735

COURSE CREDITS: 2

CORE/ELECTIVE: OPEN ELECTIVE

: 2-0-0

Pre-requisites: C/C++, Python, Eclipse, Netbeans

Course Objectives:

1. Employ correct testing terminology throughout the testing process
2. Execute specific software tests with well-defined objectives and targets.
3. Modelling techniques: UML: FSM and State charts, combinatorial design; and others.
4. Apply various testing techniques, including domain, code, fault, usage and model- based.
5. Perform a complete testing process, taking into account practical considerations.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Investigate the reason for bugs and analyze the principles in software testing to prevent and remove bugs.	Familiarity
CO-2	Implement various test processes for quality improvement.	Assessment
CO-3	Design test planning and manage the test process.	Assessment
CO-4	Apply the software testing techniques in commercial environment.	Assessment
CO-5	Design test adequacy assessment and enhancement criteria.	Assessment
CO-6	Use practical knowledge of a variety of ways to test software and an understanding of some of the tradeoffs between testing techniques.	Usage

Course Contents:

Unit	Contents	Lectures required
1	**Introduction:** Error, Fault, Failure, Test automation and the importance of testing, Developer and tester as two roles, Principles of Testing, ETVX Model, Testing Maturity Model, V-Model, Software quality, Testing and debugging (preparing, Constructing, Executing, Specifying, Assessing a test plan), test Generation Strategies, Types of testing and Classifiers C1, C2, C3, C4, and C5, Static testing **Preliminaries mathematical:** Predicates and Boolean Expressions, Control Flow Graph, Program Dependence Graph, Strings languages and regular expressions,	4
	Test Generation: a) **From Domain Partitioning:** The test selection problem, Equivalence partitioning, Boundary value analysis, Category-partition method, Cause-effect graphing. b) **From Finite State Models**: Finite State machines,	

2	Conformance testing, A Fault model, Characterization Set, The w-Method, The partial W-methos. **c) From Combinatorial design**: Combinatorial designs, A combinatorial test design process, Fault model, Latin Squares, Mutually orthogonal Latin squares, Pairwise designs: binary factors, Pairwise design: multi-valued factors, Orthogonal Arrays.	**8**
3	**Test Adequacy Assessment and Enhancement:** **a) Using Control flow:** Test adequacy basics, adequacy criteria based on control flow – Statement coverage, Decision coverage, condition coverage, MCC, LCSAJ, basis path coverage, **b) Using data Flow:** Definitions, C-use, p-use, Data flow graphs, du-path, dc-path, c-use coverage, p-use coverage, All-use coverage, k-dr chain coverage. **c) Using Mutation:** Mutation and Mutants, Test Assessment using mutation, Mutation operators, Founding principles of mutation testing, Equivalent mutants, Fault detection using mutation, Types of mutants.	**8**
4	**Phases of testing I:** **Regression testing:** Regression test process, Regression test selection, Selecting regression tests, test selection using execution trace, test selection using dynamic slicing	**4**
5	**Phases of testing II:** Unit Testing, Integration Testing, System testing, Acceptance testing.	**4**
Total lectures		**28**

Suggested Text Book(s):

1. "Foundations of Software testing," 2nd edition by Aditya P mathur, Pearson 2013
2. "Practical Software testing," 8th edition by Ilene Burnstein, Springer 2010

Suggested Reference Book(s):

1. Paul C. Jorgensen, Software testing: a Craft's man approach, CRC Press
2. Srinivasan Desikan and G. Ramesh, Software Testing: Principles and Practices, Pearson Education
3. Glenford Myers, "The Art of Software Testing", John Wiley & Sons Inc., New York, 1979.
4. Cem Kaner, Jack Falk, Nguyen Quoc, "Testing Computer Software", Second Edition, Van Nostrand Reinhold, New York, 1993.
5. Boris Beizer, "Software Testing Techniques", Second Volume, Second Edition, Van Nostrand Reinhold, New York, 1990.
6. Roger S. Pressman, "Software Engineering – A Practitioner's Approach", Fifth Edition, McGraw- Hill International Edition, New Delhi, 2001.
7. Boris Beizer, "Black-Box Testing – Techniques for Functional Testing of Software and Systems", John Wiley & Sons Inc., New York, 1995.
8. K.K. Aggarwal & Yogesh Singh, "Software Engineering", New Age International Publishers, New Delhi, 2003.

Other useful resource(s):

1. Link to NPTEL course contents: https://nptel.ac.in/courses/106105150/
2. Link to topics related to course:
   i. https://www.guru99.com/software-testing.html
   ii. https://www.inf.ed.ac.uk/teaching/courses/st/2011-12/Resource-folder/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment		Entire Semester	Assignment (2) - 1 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Software Testing Fundamentals)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	3	2	2	3	2	2	2	3	1	3	**2.4**
CO-2	3	3	3	2	3	2	3	2	2	3	1	3	**2.5**
CO-3	3	3	3	2	2	3	1	2	3	3	1	3	**2.4**
CO-4	3	3	3	2	3	3	2	2	3	3	1	3	**2.6**
CO-5	3	3	3	2	3	3	2	2	3	3	1	3	**2.6**
CO-6	3	3	3	2	3	3	2	2	2	3	1	3	**2.5**
Average	**3**	**3**	**3**	**2**	**2.7**	**2.8**	**2**	**2**	**2.5**	**3**	**1**	**3**	

Software Testing Methodologies Lab

COURSE CODE: **19B1WCI775**

COURSE CREDITS: 1

CORE/ELECTIVE: ELECTIVE

L-T-P: 0-0-2

Pre-requisite: Object Oriented Analysis and Design with UML, Software Engineering, Software Metrics, Basics of Mathematics.

Course Objectives:

1. Have an ability to apply software testing knowledge and engineering methods.
2. Have an ability to design and conduct a software test process for a software testing project.
3. To learn how to planning a test project, design test cases and data, conduct testing operations, manage software problems and defects, generate a testing report.
4. To discuss various software testing issues and solutions in software unit test; integration, regression, and system testing.
5. To gain the techniques and skills on how to use modern software testing tools to support software testing projects.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Have an ability to apply software testing knowledge and engineering methods.	Familiarity
CO-2	Have an ability to design and conduct a software test process for a software testing project.	Usage
CO-3	Have an ability to identify the needs of software test automation, and define and develop a test tool to support test automation.	Assessment
CO-4	Have an ability understand and identify various software testing problems, and solve these problems by designing and selecting software test models, criteria, strategies, and methods.	Assessment
CO-5	Have an ability to use various communication methods and skills to communicate with their teammates to conduct their practice-oriented software testing projects.	Usage
CO-6	Have basic understanding and knowledge of contemporary issues in software testing, such as component-based software testing problems.	Usage
CO-7	Have an ability to use software testing methods and modern software testing tools for their testing projects.	Usage

List of Experiments:

S. No	Description	Hours
1	Revision of Java coding using Eclipse	**2**

2	Developing Black box test cases 1: a) Using Boundary Value Analysis	**2**
3	Developing Black box test cases 2: a) Using Equivalent Classes	**2**
4	Developing Black box test cases 3: a) Using Decision Tables	**2**
5	Developing WhiteBox test cases 1: a) Performing Path testing	**2**
6	Developing WhiteBox test cases 2: a) Performing orthogonal testing	**2**
7	Developing WhiteBox test cases 3: a) Performing Coverage Analysis	**2**
8	Mutation testing and developing Mutants	**2**
9	Regression testing and Developing Regression test Cases	**2**
10	Performing GUI testing for a designed application	**2**
11	Performing Load testing for a designed application	**4**
12	Getting familiar with Profiler and performing CPU, Memory analysis in real time	**4**
	Total Lab Hours	**28**

Suggested Books/Resources:

1. 1. A Practitioner's Guide to Software Test Design, Lee Copeland, 2003,
2. The Art of Software Testing, 2nd edition, Glenford Myers, et. el., 2004
3. Software Testing Techniques, 2nd edition, Boris Beizer, 1990
4. How to Break Software: A Practical Guide to Testing, James Whittaker, 2002.
5. Testing Object-Oriented Systems: Models, Patterns, and Tools, Robert V. Binder, 1999.
6. Software Testing and Quality Assurance: Theory and Practice Paperback – 2010

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Attendance	15 Marks
4	Lab Assessment	45 Marks
	Total	100 marks

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Average
CO-1	3	2	3	2	2	3	3	3	2	3	2	2	**2.5**
CO-2	3	3	3	2	3	3	3	3	2	3	2	3	**2.8**
CO-3	3	3	3	2	2	3	3	3	3	3	2	2	**2.7**
CO-4	3	3	3	3	3	3	3	2	2	3	3	3	**2.8**
CO-5	3	3	3	2	2	2	3	3	3	3	2	2	**2.6**
CO-6	3	3	3	3	3	3	3	2	2	3	3	3	**2.8**
CO-7	3	3	3	3	3	3	2	2	3	3	3	3	**2.8**
Average	**3**	**2.9**	**3**	**2.4**	**2.6**	**2.9**	**2.9**	**2.6**	**2.4**	**3**	**2.4**	**2.6**	

Sustainable Technologies for Waste Management

COURSE CODE: 19B1WBT731

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Environmental pollution: Cause and remediation strategies

Course Objectives:

1. Sustainable strategies and technologies for waste and resource management at national and international level for overall development in this sector

Course Outcomes:

CO I. Students will know about the types of waste, their prevalence and available treatment options.

CO II: Students will be able to grasps the concepts of waste to energy technologies and apply their knowledge to look for appropriate one.

CO III. Students will develop the skill of linking waste and management strategies to society and its needs.

CO IV: Students will develop an understanding risk assessment and life cycle of the waste.

CO V: Students will be able to recognize real-world examples of waste disposal and handling

Course Content:

S.No.	Topics	No. of lectures
1	**Introduction** Concept of Sustainable Technologies for waste management.	2
	Technology Matrix for Solid Waste Management Type of Wastes and appropriate technologies, Municipal Solid Waste, Industrial waste, medical and other wastes. Status of various waste streams in India and available treatment options	5

2	**Waste to Energy Technologies** Technologies for recovering energy from waste, based in part on their potential for climate change mitigation and relevance to India, Case studies of adapted waste-to-energy technologies and evaluating their impact. The focus will be on methane, hydrogen and ethanol and next generation fuel technologies utilizing agricultural and municipality waste.	6
3	**Developing Sustainable Strategies** Corporate / Organizational responsibility, Sustainability strategy development., Management tools, Sustainable/ethical investment accounts , Silos and open access, Product development and design	5
4	**Electronic waste and Battery Waste Management** MOEFCC policy advice and carrying out activities relating to electronic/battery waste management, current status in India and global projections, hazardous substances in e- /battery waste and health perspectives, recycling technologies for e-/battery wastes, new strategies for waste collection and disposal, extended producer responsibility	5
5	**Green composites and Bioelectrochemical systems for sustainable world** Green composites: towards a sustainable future; Cellulose fiber/nanofiber from natural sources including waste-based sources; Clean production strategies; Green composites for the built environment Microbial electrosynthesis; BES for sustainable agriculture; BES for sustainable energy production and product recovery; Life cycle assessment of a BES	8
6	**Industrial Ecology & Economic, Social and legal instruments** The onset of industrial ecology and conceptual framework and linkages with waste management. Social issues and costs associated with waste management, traditional approaches to financing, the new advisory projects in India, economic incentive systems to avoid or recycle waste, Laws and obligations related to waste management, carbon foot print.	6
7	**Risk Assessment and Life cycle assessment of Waste, Case studies** Hazardous wastes and their risk assessment, available models and management, life cycle inventory and impact assessment	5
	Total	42

Evaluation scheme:

T1	1 hour	15 (course covered upto T1)
T2	1.5 hour	25 (course covered upto T2, including that covered upto T1)
T3	2 hours	35 (total syllabus)

Tutorials, quiz, and home assignments	25
Total	100

Text books:

1. Concept of genetics by William S Klug and M.R. Cummings
2. Principles of Genetics. D P Snustad, M J Simmons

Reference books:

1. Sustainable Solid Waste Management. A system engineering approach. Chana Ni-Ben and Pires Ana. IEEE Press.
2. E-waste: Implications, regulations, and management in India and current global best practices. Rakesh Johri. Teri Press.
3. Green Composites: Natural and waste-based composites for a sustainable future by Caroline Baillie and Randika Jayasinghe
4. Scientific and research articles from Elsevier, Springer, Wiley and RSC Journals
5. Solid Waste Management - A Manual by All India Institute of LocalSelf-Government Publications
6. Toxic and Hazardous Waste by Sinha P.C.
7. Manual on Solid Waste Management by Palnitkar, Sneha
8. Basic Hazardous Waste Management by William C. Blackman
9. Management Of Municipal Solid Waste by Ramchandra T. V.
10. Solid Waste Management by H V. Bijalani
11. TED talks

Wireless Sensor Networks: Protocols and Applications

COURSE CODE: 19B1WCI841

COURSE CREDITS: 3

CORE/ELECTIVE: OPEN ELECTIVE

L-T-P: 3-0-0

Pre-requisites: Introduction to Computer Networks

Course Objectives:

- Architect sensor networks for various application setups.
- Explore the design space and conduct trade-off analysis between performance and resources.
- Assess coverage and conduct node deployment planning.
- Devise appropriate data dissemination protocols and model links cost.
- Determine suitable medium access protocols and radio hardware.
- Prototype sensor networks using commercial components.
- Provision quality of service, fault-tolerance, security and other dependability requirements while coping with resource constraints.
- Evaluate the performance of sensor networks and identify bottlenecks.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	To architect WSN for various application setups	Familiarity
CO-2	To explore the design space and conduct trade-off analysis between performance and resources.	Assessment
CO-3	To assess coverage and conduct node deployment planning.	Assessment
CO-4	To devise appropriate data dissemination protocols and model links cost.	Assessment
CO-5	To determine suitable medium access protocols and radio hardware.	Assessment
CO-6	To create prototype wireless sensor networks using simulator.	Assessment
CO-7	To provision quality of service, fault-tolerance, security and other dependability requirements while coping with resource constraints.	Assessment
CO-8	To evaluate the performance of sensor networks and identify	Assessment

	bottlenecks.	
CO-9	To Explore Security node clone attack, opportunistic routing Protocol and information Fusion in WSN.	Usage

Course Contents:

Unit	Contents	Lectures required
1	**Introduction to WSN,** Applications of WSN, Challenges for WSN, Why Sensor Networks different, Enabling technologies for WSN **Architectures:** Single Node Architectures, Hardware Components, Energy Consumption of Sensor node, operating System and execution environment.	6
2	**Network Architectures:** Sensor networks Scenario, Optimization Goals and figures of merits, Design Principles of WSN, Service interface of WSN. **Communication Protocol:** Physical Layer introduction. Wireless Channel and communication fundamentals, physical layer and transeceiver design consideration in WSN.	6
3	**MAC Protocols:** Fundamental of MAC protocols, Low duty cycle protocols, Contention based protocol, schedule based protocols, IEEE802.15.4 MAC Protocol. **Link Layer Protocols:** Fundamentals, Tasks and requirements, Error control, Framing, Link Management.	6
4	**Naming and Addressing**: Fundamentals, Address and name management in WSN, Assignment of MAC addresses **Time Synchronization:** Introduction, protocol based on sender/receiver synchronization	6
5	**Localization and Positioning:** properties of localization and positioning problems, single hop localization, multihop localization, etc. **Topology Control:** Motibvation and basic idea, power control, clustering etc.	6
6	**Routing Protocol:** Energy efficient, unicast, broadcast, Opportunistic routing etc. **Data centric and content based networking:** data centric routing, Data Aggregation, data centric storage	6
7	**Transport layer and QoS:** Coverage and deployment, reliable data Transport, packet delivery, block delivery. **Advanced topics**	6
	Total lectures	**42**

Suggested Text Book(s):

- Protocols and Architectures for Wireless Sensor Networks,
  Holger Karl, Technical University of Berlin, Andreas Willig, University of Potsdam, Wiley, ISBN: 0-470-09510-5, June 2005. (Textbook)
  - Wireless Sensor Networks, Cauligi S. Raghavendra, University of Southern California, Krishna Sivalingam, University of Maryland Baltimore County, Taieb M. Znati, University of Pittsburg , Springer, ISBN: 1-4020-7883-8, August 2005

Other useful resource(s):

- F. Akyildiz, W. Su, Y. Sankarasubramaniam, and E.Cayirci, "Wireless sensor networks: a survey," Computer Networks, Vol. 38, No. 4, pp. 393—422, 2002.
- Jeongyeup Paek and Krishna Chintalapudi and John Cafferey and Ramesh Govindan and Sami Masri, "A Wireless Sensor Network for Structural Health Monitoring: Performance and Experience," in theProceedings of the Second IEEE Workshop on Embedded Networked Sensors (EmNetS-II), Syndney, Australia, May 2005.
- K. Martinez, J. Hart and R. Ong, "Environmental Sensor Networks," IEEE Computer Magazine, August 2004.
- S. Brennan, A. Mielke, D. Torney and A. Maccabe, "Radiation Detection With Distributed Sensor Networks," IEEE Computer Magazine, August 2004.
- M. Maroti, G. Simon, A Ledeczi and J. Sztipanovits, "Shooter Localization in Urban Terrain," IEEE Computer Magazine, August 2004.
- R. Szewczyk, A. Mainwaring, J. Polastre and D. Culler, "An Analysis of a Large Scale Habitat Monitoring Application," Proceedings of ACM SenSys, November 2004.
- K. Mechitov, W. Kim, G. Agha, and T. Nagayama, "High-Frequency Distributed Sensing for Structure Monitoring," Proceedings of the First International Conference on Networked Sensing Systems, Tokyo, Japan, June 2004.
- http://www.extremetech.com/article2/0,1697,1744363,00.asp
- http://www.eetimes.com/story/OEG20030221S0018
- Sensor Networks: http://www.ece.gatech.edu/research/labs/bwn/UWASN/publication.html
- A. Woods and J. A. "Stankovic, Denial of Service Attacks in Sensor Networks," IEEE Computer, October 2002, pp. 54-62.

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment		Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course Outcomes	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	2	3	2	2	3	3	3	3	3	1	3	**2.6**
CO-2	3	3	3	2	2	3	3	3	3	3	1	3	**2.7**
CO-3	3	3	3	3	3	3	3	3	3	3	1	3	**2.8**
CO-4	3	3	3	2	3	3	3	3	3	3	1	3	**2.8**
CO-5	3	3	3	3	2	3	3	3	2	3	1	3	**2.7**
CO-6	2	3	3	3	3	2	3	3	3	3	1	3	**2.7**
CO-7	3	2	2	3	3	3	3	3	2	2	2	2	**2.5**
CO-8	3	2	2	2	2	3	3	3	3	2	2	2	**2.4**
CO-9	3	3	3	2	2	3	3	3	2	2	3	3	**2.7**
Average	**2.9**	**2.7**	**2.8**	**2.4**	**2.4**	**2.9**	**3**	**3**	**2.7**	**2.7**	**1.4**	**2.8**	**2.6**

Applied Medical Signal Processing

COURSE CODE:

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

1. To introduce different biomedical signals.
2. To apply different methods to analyze and filter the signals.
3. To detect events in signals used for diagnosis.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Identify and reproduce signal processing methods used in forefront biomedical sciences	Familiarity
CO-2	Able to filter out the noise and artifacts from the medical signals.	Usage
CO-3	Critically assess the appropriateness of biomedical signal processing techniques for various problems in the field	Usage
CO-4	Evaluate the effectiveness of techniques applied to biomedical signals against specific benchmarks	Assessment

Course Contents:

Unit	Contents	Lectures required
1	Introduction: Preliminaries, Medical signal origin & dynamics (ECG, EEG, EMG etc.)	4
2	Filtering for removal of artifacts: Statistical Preliminaries, Time domain filtering (Synchronized Averaging, Moving Average, Derivative-based operator), Frequency Domain Filtering (Notch Filter), the Weiner Filter, Adaptive Filter and related design problems.	12
3	Waveform Analysis: Illustrations of problem with case studies, Morphological analysis, transform analysis, correlation coefficient, Periodogram, Averaged periodogram, Blackman-Tukey Spectral Estimator, Daniell's Spectral Estimator, Measures derived from PSD	9
4	Modeling of Biomedical Systems: Motor unit firing pattern, Autoregressive model, Autocorrelation method, Parametric modeling, Levinson-Durbin algorithm, Covariance method, Spectral matching and parameterization, Model order selection	12

5	Pattern classification and diagnostic decision: Illustrations of problem with case studies, Feature extractions from medical signals, supervised and unsupervised pattern classification, Reliability of features, classifiers and decisions.	5
Total lectures		42

Suggested Text Book(s):

1. Rangaraj M. Rangayyan, Biomedical Signal Analysis, 2nd Ed., Wiley, 2015.
2. Willis J. Tompkins , Biomedical Digital Signal Processing, 10th Ed., Prentice Hall, 2011
3. D C Reddy, Biomedical Signal Processing: Principles and Techniques, 1st Ed., Tata McGraw-Hill Publishing Co. Ltd, 2005
4. J G Webster, Medical Instrumentation: Application & Design, 3rd Ed. John Wiley & Sons Inc., 2007

Suggested Reference Book(s):

1. R. S Khandpur and Raghbir Khandpur: Biomedical Instrumentation, 2nd Ed., McGraw-Hill Education , 2003.
2. Leslie Cromwell, Fred Weibell J, Erich Pfeiffer. A: Biomedical Instrumentation and Measurements, Prentice-Hall India, 2nd Edition, 1997.
3. C Raja Rao, S K Guha, Principles of Medical Electronics and Biomedical Instrumentation, 1st Ed., Universities Press, 2001

Other useful resource(s):

Link to NPTEL course contents:

1. https://nptel.ac.in/courses/108105101/
2. https://onlinecourses.nptel.ac.in/noc19_ee23/preview

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes(2) -10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Applied Medical Signal Processing)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	1	3	2	3	2	2	3	2	2	1	3	2.28
CO-2	3	3	3	3	3	1	1	2	2	2	1	3	2.25
CO-3	3	3	3	3	3	1	1	2	2	2	1	3	2.25
CO-4	3	3	3	3	3	1	1	2	2	2	1	3	2.25
Average	2.75	2.5	3	2.75	3	1.25	1.25	1.25	2	2	1	3	

Adaptive Signal Processing and Machine Intelligence

COURSE CODE: XXXXXXXX

COURSE CREDITS: XX

CORE/ELECTIVE: XX

: XX

Pre-requisite: Prerequisites are some prior knowledge to signals and systems, basics of digital signal processing and machine learning. Student should have a basic level of expertise in programming and mathematics.

Course Objectives:

1. To understand the fundamentals of statistical properties of complex-valued and multidimensional signals
2. Algorithms and applications of adaptive signal processing to real-time streaming data
3. Become familiar with learning algorithms for multidimensional signals
4. To study State of the Art machine learning algorithms in real time signal processing applications.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Gain in-depth understanding of adaptive signal processing algorithms	Familiarity
CO-2	Examine statistical properties and performance of these algorithms in real-world applications.	Assessment
CO-3	Apply adaptive learning algorithms for multidimensional signals	Assessment
CO-4	Study of real world case studies and applications	Usage

Course Contents:

Unit	Contents	Lectures required
1	Introduction: Review of orthogonal transforms: DFT, DCT and Haar, Properties of DFT, Computation of DFT: FFT and structures, Decimation in time, Decimation in frequency, Linear convolution using DFT, Basic FIR/IIR filter structures, FIR/IIR Cascaded lattice structures, Parallel all pass realization of IIR transfer functions, Computational complexity of filter structures	8
2	Basics of Adaptive Signal Processing: Linear algebra and random processes, Optimal estimation, Linear estimation. Steepest-descent algorithms. Stochastic-gradient algorithms. Kalman filtering. Particle filtering. Blind de-convolution and beam forming, Robust adaptive filters, Adaptive filters, Least Mean Squares algorithm	8
3	Machine Learning for Signal Processing: Distance based signal classification, nearest neighbor classifier, Hilbert space, Linear systems,	7

	circulant matrices, convolution, eigenvector decomposition using SVD, Bayes classifiers based signal detection, dimensionality reduction using PCA	
4	Kernel based Machine Learning for Signal Processing: Review of support vector machine (SVM), Classification and Regression using SVM, Properties of Kernels, Non-Mercer Kernels, Kernel Selection, Multiple Kernel Learning, Kernel features	7
5	Deep Neural Network for Signal Processing: Nonlinear learning algorithms and architectures, such as dynamical perceptrons, feedforward and recurrent neural networks, and their connection with general neural networks and deep learning. Tensors for Big Data applications	6
6	Applications in Real World Domain: Transfer Learning, Dictionary learning, Attention models, Attribute-based learning, Deep learning for wireless applications, speech and image processing, sparse signal processing and compressive sensing for machine learning.	6
Total lectures		42

Suggested Reference Book(s):

1. C.M. Bishop, "Pattern Recognition and Machine Learning", 2nd Edition, Springer, 2011.
2. D. Yu and L. Deng, "Automatic Speech Recognition: A Deep Learning Approach" , Springer, 2016.
3. I. Goodfellow, Y, Bengio, A. Courville, "Deep Learning", , MIT Press, 2016.

Other useful resource(s):

1. http://home.iitk.ac.in/~vipular/stuff/2019_MLSP.html
2. http://web.stanford.edu/class/ee269/index.html
3. http://intranet.ee.ic.ac.uk/electricalengineering/eecourses_t4/course_content.asp?c=EE4-13&s=D4

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Adaptive Signal Processing and Machine Intelligence)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	3	3	2	1	1	1	2	2	2	2	1.91
CO-2	3	3	3	3	3	2	1	1	3	2	1	3	2.33
CO-3	2	3	2	2	2	2	2	2	2	2	1	2	2.00
CO-4	3	3	3	3	2	1	1	1	2	3	2	3	2.25
Average	2.50	2.75	2.75	2.75	2.25	1.50	1.25	1.25	2.25	2.25	1.50	2.50	

Antenna and Wave Propagation

COURSE CODE: 18B1WEC742

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

1. To make students understand the fundamental theory and concepts of antenna and propagation of waves.
2. Make them aware to the radiation characteristics of different types of antennas, their measurement and applications of various antennas.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Comprehend the fundamental theory and concepts of radiation, antenna and significance of antenna parameters.	Familiarity
CO-2	Assess the power and usefulness of UHF, VHF and Microwave Antennas, microstrip patch antennas their requirements, specifications, characteristics and design relations.	Assessment
CO-3	To define and distinguish between different phenomenon of wave propagation (ground wave, space wave and sky wave), their frequency dependence, and estimate their characteristics, identifying their profiles and parameters involved.	Assessment
CO-4	Reveal different applications of the various types of antenna to solve engineering and other problems	Usage

Course Contents:

Unit	Contents	Lectures required
1	ANTENNA FUNDAMENTALS: Introduction, Radiation Mechanism – single wire, 2 wire, dipoles, Current Distribution on a thin wire antenna. Antenna Parameters - Radiation Patterns, Beamwidths, Beam Area, Radiation Intensity, Beam Efficiency, Directivity, Gain and Resolution, Antenna Apertures, Aperture Efficiency Antenna temperature and signal to noise ratio.	7
2	RADIATION OF ELECTRIC DIPOLE: Potential functions and the electromagnetic field, Oscillating electric dipole derivations for E and H field components in spherical coordinate systems, Power Radiated by a current element, Application to antennas, Radiation from quarter wave monopole and half wave dipoles, equality of directional patterns and effective lengths of transmitting and receiving antennas, directional properties of dipole antennas, antenna feeding methods.	8
3	ANTENNAS FOR SPECIAL APPLICATIONS: Broadband antenna, Frequency-independent antenna, log periodic antennas, Antennas design consideration for satellite communication, antenna for terrestrial mobile communication systems, GPR, Embedded antennas, UWB, Plasma	6
4	ANTENNA MEASUREMENTS: Radiation Pattern measurement, Distance requirement for uniform phase, uniform field amplitude requirement, Introduction to phase measurement; Gain Measurement: Comparison method, Near field method, Introduction to current distribution measurement, Measurement of antenna efficiency, measurement of Noise figure and noise temperature of an antenna polarization measurement, Anechoic Chamber measurement.	7

5	WAVE PROPAGATION - I: Concepts of Propagation – frequency ranges and types of propagations. Ground Wave Propagation–Characteristics, Parameters, Wave Tilt, Flat and Spherical Earth Considerations. Sky Wave Propagation – Formation of Ionospheric Layers and their Characteristics, Mechanism of Reflection and Refraction, Critical Frequency, MUF & Skip Distance – Calculations for flat and spherical earth cases, Optimum Frequency, LUHF, Virtual Height, Ionospheric Abnormalities, Ionospheric Absorption.	7
6	WAVE PROPAGATION – II: Fundamental Equation for Free-Space Propagation, Basic Transmission Loss Calculations. Space Wave Propagation – Mechanism, LOS and Radio Horizon. Tropospheric Wave Propagation – Radius of Curvature of path, Effective Earth's Radius, Effect of Earth's Curvature, Field Strength Calculations, M-curves and Duct Propagation, Tropospheric Scattering.	7
Total lectures		42

Suggested Text Book(s):

1. E.C.Jordan and Balmain: Electromagnetic waves and Radiating Systems, 2nd Edition, PHI, 2006
2. Constantine A. Balanis: Antenna Theory Analysis and Desin, John Wiley, 2nd Edition,2007.

Suggested Reference Book(s):

1. John D.Kraus, Ronald J Marhefka and Ahmad S Khan: Antennas for all Applications, Tata McGraw-Hill Book Company, 3rd Edition, 2007.
2. G.S.N.Raju: Antenna Wave Propagation, Pearson Education, 1st Edition,2004.
3. R.E.Collins, "Antenna and Radiowave propagation", 3rd Edition, Mc Graw Hill, 2005.

Other resources/ learning website:

www.nptel.ac.in
www.antenna-theory.com

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Antenna and Wave Propagation)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	2	2	3	2	1	1	1	2	3	3	2.17
CO-2	3	3	3	3	3	2	1	1	1	2	2	3	2.25
CO-3	3	3	3	3	3	2	1	1	1	2	2	3	2.25
CO-4	3	3	3	3	3	3	3	2	3	3	3	3	2.92
Average	3	3	2.75	2.75	3	2.25	1.5	1.25	1.5	2.25	2.5	3	2.40

OFDM and Applications

COURSE CODE: 18B1WEC736

COURSE CREDITS: 3

CORE/ELECTIVE: Elective

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

1. Learn the fundamental concepts of high rate OFDM communication system focusing on the physical layer.
2. Analyze the design requirements of various OFDM standards.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Learn the fundamentals of OFDM communication system.	Familiarity
CO-2	Performance analysis of OFDM signals over AWGN and wideband channels.	Assessment
CO-3	Demonstrate the challenging issues in OFDM system.	Assessment
CO-4	Apply OFDM to the practical communication systems.	Usage

Course Contents:

Unit	Contents	Lectures required
1	Introduction and Basics of OFDM: High rate wireless applications; Wireless channel; Interference and noise; OFDM concept and system model- block diagram, design of the OFDM signal, OFDM system model, FFT implementation, cyclic extension, power spectrum and spectrum efficiency, synchronization errors; Channel capacity and OFDM; Comparison with single-carrier; Design example; Performance of an uncoded OFDM system.	10
2	Impairments of Wireless Channels to OFDM Signals: Time varying impairments; Effect of sampling clock offset; Effect of timing offset; Effect of delay spread; System Non Linearity. Other Multicarrier Modulation; Mathematical modeling and analytical evaluation of the BER of OFDM System.	8
3	OFDM Transmission over Gaussian channels and wideband channels. Synchronization: Overview of synchronization schemes- timing offset estimation, frequency offset estimation, acquisition versus tracking; Timing offset estimation-pilot based methods, non-pilot based methods; Frequency offset estimation- pilot based methods, non-pilot based methods; Joint time and frequency offset estimation and correction.	8
4	OFDM versus-MC-CDMA Peak Power Ratio: The peak power problem; Distribution of PAP ratio; Maximum PAPR of an N subcarrier OFDM signal; PAPR reduction with signal distortion; Limits for distortion-less PAPR-reduction; Techniques for distortion-less PAPR reduction-selective mapping, optimization techniques, modified signal constellation; PAPR reduction effect on the system performance; PAPR reduction for multicarrier CDMA.	8
5	OFDM applications: MIMO OFDM- synchronization for MIMO OFDM, A practical OFDM system: Fixed broadband wireless access, system requirements, parameter selection, communication protocol, frame structure, MAC consideration and conformance.	8
Total lectures		42

Suggested Text Book(s):

1. Ye Li and Gordon L. Stuber: Orthogonal Frequency Division Multiplexing for Wireless Communications,

Unit III

Mathematical models in biology

4 lectures

Population dynamics; oscillations, circadian rhythms, developmental patterns, symmetry in biological systems, fractal geometries, size-limits & scaling in biology, modeling chemical reaction networks and metabolic networks.

Unit IV

Statistics

5 lectures

Probability: counting, conditional probability, discrete and continuous random variables; Error propagation; Populations and samples, expectation, parametric tests of statistical significance, nonparametric hypothesis tests, linear regression, correlation & causality, analysis of variance, factorial experiment design.

Recommended Textbooks and References:

1. Stroud, K. A., & Booth, D. J. (2009). *Foundation Mathematics*. New York, NY: Palgrave Macmillan.
2. Aitken, M., Broadhursts, B., & Haldky, S. (2009) *Mathematics for Biological Scientists*. Garland Science.
3. Billingsley, P. (1986). *Probability and Measure.* New York: Wiley.
4. Rosner, B. (2000). *Fundamentals of Biostatistics*. Boston, MA: Duxbury Press.
5. Daniel, W. W. (1987). *Biostatistics, a Foundation for Analysis in the Health Sciences*. New York: Wiley.

Basics of Chemistry and Physics

Credits

2

Course Objectives

The objectives of this course are to cover all essentials required to appreciate physico-chemical principles underlying biological processes.

Student Learning Outcomes

Students should be able to have a firm foundation in fundamentals and application of current chemical and physical scientific theories.

Unit I

Basic physics for biologists

12 lectures:
10 hours teaching +
2 hours tutorials

Physical quantities and their dynamics: definitions and dimensions; vectors & scalars, displacement, velocity, acceleration, kinematic formulas, angular momentum, torque *etc.* force, power, work, energy (kinetic & potential/electric charge separation, electromagnetic spectrum, photons *etc.*); springs & Hookes laws; elastic and inelastic collisions; Newton's law of motions (centripetal and centrifugal forces *etc.*); simple harmonic motions, mechanical waves, Doppler effect, wave interference, amplitude, period, frequency & wavelength; diffusion, dissipation, random walks, and directed motions in biological systems; low Reynolds number - world of Biology, buoyant forces, Bernoulli's equation, viscosity, turbulence, surface tension, adhesion; laws of thermodynamics: Maxwell Boltzmann distribution, conduction, convection and radiation, internal energy, entropy, temperature and free energy, Maxwell's demon (entropic forces at work in biology, chemical assemblies, self-assembled systems, role of ATP); Coulomb's law, conductors and insulators, electric potential energy of charges, nerve impulses, voltage gated channels, ionic conductance; Ohms law (basic electrical quantities: current, voltage & power), electrolyte conductivity, capacitors and capacitance, dielectrics; various machines in biology *i.e.* enzymes, allostery and molecular motors (molecules to cells and organisms).

Unit II

Basic chemistry for biologists

Basic constituents of matter - elements, atoms, isotopes, atomic weights, atomic numbers, basics of mass spectrometry, molecules, Avogadro number, molarity, gas constant, molecular weights, structural and molecular formulae, ions and polyatomic

12 lectures:
10 hours teaching +
2 hours tutorials

ions; chemical reactions, reaction stoichiometry, rates of reaction, rate constants, order of reactions, Arrhenious equation, Maxwell Boltzmann distributions, rate-determining steps, catalysis, free-energy, entropy and enthalpy changes during reactions; kinetic versus thermodynamic controls of a reaction, reaction equilibrium (equilibrium constant); light and matter interactions (optical spectroscopy, fluorescence, bioluminescence, paramagnetism and diamagnetism, photoelectron spectroscopy; chemical bonds (ionic, covalent, Van der Walls forces); electronegativity, polarity; VSEPR theory and molecular geometry, dipole moment, orbital hybridizations; states of matter - vapor pressure, phase diagrams, surface tension, boiling and melting points, solubility, capillary action, suspensions, colloids and solutions; acids, bases and pH - Arrhenious theory, pH, ionic product of water, weak acids and bases, conjugate acid-base pairs, buffers and buffering action *etc*; chemical thermodynamics - internal energy, heat and temperature, enthalpy (bond enthalpy and reaction enthalpy), entropy, Gibbs free energy of ATP driven reactions, spontaneity versus driven reactions in biology; redox reactions and electrochemistry - oxidation-reduction reactions, standard cell potentials, Nernst equation, resting membrane potentials, electron transport chains (ETC) in biology, coupling of oxidative phosphorylations to ETC; theories of ATP production and dissipation across biological membranes; bond rotations and molecular conformations - Newman projections, conformational analysis of alkanes, alkenes and alkynes; functional groups, optically asymmetric carbon centers, amino acids, proteins, rotational freedoms in polypeptide backbone (Ramachandran plot).

Recommended Textbooks and References:

1. Baaquie, B. E. (2000). *Laws of Physics: a Primer*. Singapore: National University of Singapore.
2. Matthews, C. P., & Shearer, J. S. (1897). *Problems and Questions in Physics*. New York: Macmillan Company.
3. Halliday, D., Resnick, R., & Walker, J. (1993). *Fundamentals of Physics.* New York: Wiley.
4. Ebbing, D. D., & Wrighton, M. S. (1990). *General Chemistry*. Boston: Houghton Mifflin.
5. Averill, B., & Eldredge, P. (2007). *Chemistry: Principles, Patterns, and Applications*. San Francisco: Benjamin Cummings.
6. Mahan, B. H. (1965). *University Chemistry*. Reading, MA: Addison-Wesley Pub.
7. Cantor, C. R., & Schimmel, P. R. (2004). *Biophysical Chemistry*. San Francisco: W.H. Freeman.

Laboratory I: Biochemistry & Analytical Techniques

Credits

4

Course Objectives

The objective of this laboratory course is to introduce students to experiments in biochemistry. The course is designed to teach students the utility of set of experimental methods in biochemistry in a problem oriented manner.

Student Learning Outcomes

On completion of this course, students should be able to:

- To elaborate concepts of biochemistry with easy to run experiments;
- To familiarize with basic laboratory instruments and understand the principle of measurements using those instruments with experiments in biochemistry.

Syllabus

1. Preparing various stock solutions and working solutions that will be needed for the course.

XXXXXXXX: Bioinformatics Data Management

Course Credit: 4 (3-1-0)
Semester: III

Introduction

Bioinformatics is a highly interdisciplinary domain and is an excellent source of diversified data. This diversified data needs attention in the collection, analysis and management. Database Management Systems (DBMS) consists of a set of interrelated data and a set of programs to access that data. They underpin any computer system and are therefore fundamental to any programme of study in information science and engineering. An understanding of DBMS is crucial in order to appreciate the limitations of data storage and application behavior and to identify why performance problems arise. With the advent of new technologies in Biological sciences, enormous amount of data is being generated in last two decades. DBMS can support the management of this data through Bioinformatics domain.

Students who complete this course are expected to develop the ability to design, implement and manipulate databases for various biological and medical science domains. Students will apply and build databases for various day to day real life scenarios and real life applications for several diseases and biomedical applications. The course will by and large be structured but will introduce open-ended data base problems for biological data.

Course Objectives (Post-conditions)

Knowledge objectives:

- Understand diversity of biological and biomedical data.
- Ability to build normalized databases.
- Knowledge of Entity Relationship Modeling.
- Familiarity with SQL, embedded SQL and PLSQL.
- Familiarity with query processing and query optimization techniques.
- Understanding of transaction processing.
- Ability to handle recovery and concurrency issues in biological systems.
- Familiarity with ODBC, JDBC.

Application objectives:

- Develop the ability to design, implement and manipulate databases.
- Introduce students to build database management systems.
- Apply DBMS concepts to various biological and biomedical applications.

Expected Student Background (Preconditions)

- Introduction to any programming language (Preferably, C/C++)
- Data Structures

Topics Outline:

S NO	Topics	Hrs
1	To understand complexity of biological data and Introduction to Database Management Systems	2
2	Introduction to Conceptual Modeling	3
3	Relational Model	2
4	Relational Languages like SQL (including JDBC for database connectivity, ODBC, JDBC and SQLJ)	5
5	Integrity and Security	2
6	Database Design with special relevance to biological data dimensions	5
7	Object oriented and Object Relational Database	4
8	File Storage Methods	2
9	Query Optimization	2
10	Transaction Management	6
11	Database System Architecture	2
12	Development of template databases of biological and biomedical domains	4
13	Case Studies of various Bioinformatics databases	3
	Total	42

References

1. Silberschatz, Korth and Sudarshan, "Database System Concepts", 6th Edition,McGraw Hill, 2010
2. Elmasri and Navathe, "Fundamentals of Database Systems", 6th Edition, Pearson, Addison-Wesley, 2010
3. C.J. Date, "An Introduction to Database Systems", 8th Edition, Addison-Wesley, 2003
4. Ramakrishnan & Gherke, Database Management Systems, 2nd Edn., McGraw
5. Connolly and Begg, "Database Systems", 4th Edn., Addison-Wesley, 2005
6. Toby, Lightstone and Jagadish, "Database Modeling and Design", 5th Edn, Elsevier, 2011
7. Coronel and Rob, "Database Systems", 9th Edn., Cengage, 2011
8. IEEE / ACM Transactions on Database Systems (TODS)
9. DBMS related Journals

Evaluation Scheme:

S.No	Examination	Marks
1	T-1	15
2	T-2	25
3	T-3	35
4	*Internal Marks	25

*Internal Marks Breakdown:

Assignments	8 marks (4x2)
Quizzes	12 marks (4x3)
Regularity/Attendance	5 Marks

XXXXXXXX: Bioinformatics Data Management Lab

Course Credit: 1 (0-0-2) Semester: III

Objective:

- Develop the ability to design, implement and manipulate bio oriented datasets.
- Introduce students to build database management systems.
- Apply DBMS concepts to various biological and biomedical domain examples and real life applications.

Learning Outcomes:

- Understand diversity of biological and biomedical data.
- Ability to build normalized databases.
- Knowledge of Entity Relationship Modeling.
- Familiarity with SQL, embedded SQL and PLSQL.
- Familiarity with query processing and query optimization techniques.
- Understanding of transaction processing.
- Ability to handle recovery and concurrency issues.
- Familiarity with ODBC, JDBC.

List of Experiments

S NO	Topics	Hrs
1	**ER Model**: An entity-relationship model (ERM) is an abstract and conceptual representation of data. Entity-relationship modeling is a database modeling method, used to produce a type of conceptual schema or semantic data model of a system. Learn the dimensional diversity of high throughput biological data.	2
2	**EER Model**: In computer science, the enhanced entity-relationship (EER) model is a high-level or conceptual data model incorporating extensions to the original entity-relationship (ER) model, used in the design of databases. It was developed by a need to reflect more precisely properties and constraints that are found in more complex databases.	2
3	**Relational Model**: The relational model for database management is a database model based on first-order predicate logic, first formulated and proposed in 1969 by E.F. Codd. The model uses the concept of a mathematical relation, which looks somewhat like a table of values - as its basic building block, and has its theoretical basis in set theory and first-order predicate logic.	2

4	**1 NF**: First normal form (1NF or Minimal Form) is a normal form used in database normalization. A relational database table that adheres to 1NF is one that meets a certain minimum set of criteria. These criteria are basically concerned with ensuring that the table is a faithful representation of a relation and that it is free of repeating groups.	2
5	**2 NF**: Second normal form (2NF) is a normal form used in database normalization. 2NF was originally defined by E.F. Codd in 1971. A table that is in first normal form (1NF) must	2
	meet additional criteria if it is to qualify for second normal form.	
6	**3 NF**: The Third normal form (3NF) is an important form of database normalization. 3NF is said to hold if and only if both of the following conditions hold: • The relation R (table) is in second normal form (2NF) • Every non-prime attribute of R is non-transitively dependent (i.e. directly dependent) on every candidate key of R.	2
7	**BCNF**: A relation R is in Boyce-Codd normal form (BCNF) if and only if every determinant is a candidate key. The definition of BCNF addresses certain (rather unlikely) situations which 3NF does not handle.	2
8, 9	**SQL-1**: In this lab., we discuss basic SQL operations like creating a table, deleting a table, changing the schema of the table, primary key and foreign key constraints on a table and creating indexes on tables.	4
10, 11	**SQL-2**: Its scope includes efficient data insert, query, update and delete, schema creation and modification, and data access control. In this lab., we discuss SQL operations for populating the tables like inserting into a table, deleting values from a table, and updating the content of the tables.	4
12	**SQL-3**: In this Lab., we discuss SQL operations for viewing the contents of an SQL database, and various operations that we can do using SQL.	2
13, 14	Development of Bioinformatics databases for biological and biomedical domains	4
	Total	28

References

1. “Database Systems: A Practical Approach to design, Implementation and Management”. Thomas Connolly, Carolyn Begg; Third Edition, Pearson Education.
2. "Fundamentals of Database Systems" Elmasri, Navathe, Pearson Education.
3. Bipin C Desai, ?An Introduction to Database Systems?, Galgotia. Publications Pvt Limited, 2001
4. “An Introduction to Database Systems”, C.J.Date, Pearson Education.
5. “A first course in Database Systems”, Jeffrey D. Ullman, Jennifer Windon, Pearson, Education.
6. “Data Management: databases and organization”, Richard T. Watson, Wiley.
7. “ Data Modeling Essentials”, Graeme C. Simxion, Dreamtech.
8. Introduction to Data Base Management, Naveen Prakash, Tata McGraw Hill
9. “Oracle 8i manuals”.

Evaluation Scheme:

1. Mid Term Exam (Viva and Written Exam)	20
2. End term Exam (Viva and Written Exam)	20
3. Lab Records	15
4. Regular Assessment (Quality and quantity of experiment performed, Learning laboratory skills, Attendance etc.)	30
5. Project (Template Bioinformatics Database)	15
Total	**100**

Bio Electronics Sensors

COURSE CODE:

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Analog Electronics

Course Objectives:

1. To study transducers and sensors (bio sensors)
2. to study bio-potentials, bio-electrodes and bio-signal amplifiers

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Gain knowledge on sensors, actuators and transducers	Familiarity
CO-2	Learn to design circuits of bio-sensor for electrical and nonelectrical signals	Usage
CO-3	Acquaint with different types of amplifiers used for biosensors	Familiarity
CO-4	Learn about bio-potential and bio-potential amplifiers	Assessment

Course Contents:

Unit	Contents	Lectures required
1	Introduction: Introduction to Sensor, Bio electronics, Bioelectronics Sensor, Systems biology and Synthetic biology	4
2	Electrodes, Sensors and transducers: Sensor/Actuators, Active v/s passive sensors, sensor error sources, sensor terminology, Types of Sensors, Bio sensor, Block diagram of Bio-sensor for electrical and non electrical signals, electrodes for biophysical sensing, transducers, performance parameters of sensors, complete circuit diagram of bio sensor.	8
3	Bio-potential Electrodes: The electrode-electrolyte interface, polarization, polarizable and non-polarizable electrodes, Electrode behavior and circuit models, body surface recording electrodes, internal electrodes, micro electrode, macro electrode	4
4	Bio-electric Amplifiers: Voltage, current, power amplifiers, Low gain, medium gain, high gain amplifiers	6
5	Bio-potentials: ECG, EEG, EMG, ERG, EOG, its amplitude and bandwidth, Electrodes for Bio-potential Recordings, Electrical Interference Reduction.	6
6	Bio-potential Amplifiers: Operational amplifiers, basic amplifier configurations, multiple input circuits, differential amplifiers, signal processing circuits, isolation amplifiers, IMRR, ECG Amplifier, functional block, interference from electric devices, transient protection, common mode and other interference reduction circuits, Driven right leg circuit, amplifiers	8

	for other bio-potential signals, pre amplifier.	
7	Bio-signal Amplifiers : Instrumentation amplifier, Chopper Amplifier, Carrier Amplifier	6
Total lectures		42

Suggested Text Book(s):

1. Carr, J. J., Brown, J. .M., "Introduction to Biomedical Equipment Technology," 4th Ed, Pearson, 2001.
2. Reddy, D. D., Hussian, O.M., Gopal, D.V. R., Rao, D. M., Sastry, K.S. "Biosensors and Bioelectronics," I.K. International Pub., 2012
3. Gayakwad, R. A., "Op-amps and Linear Integarted Circuits," 4th Ed., PHI, 2000.
4. Klir, G. J., Yuan, B, "Fuzzy Sets and Fuzzy Logic," PHI. Pearson, 1995.

Suggested Reference Book(s):

1. Webster JG (Ed.), "Medical Instrumentation, Application and Design," 4th Ed., John Wiley & Sons, 2016.
2. Chatterjee S and Miller A, "Biomedical Instrumentation Systems," Cengage Learning, 2018

Other useful resource(s):

1. NPTEL ONLINE COURSES NPTEL: Biomedical Signal Processing https://nptel.ac.in/courses/108105101/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course Outcomes (Bio Electronics Sensors)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO1	3	3	2	1	1	2	X	X	X	X	X	2	1.17
CO2	3	3	3	2	2	2	X	X	1	2	2	3	1.92
CO3	3	3	2	1	1	2	X	X	X	1	1	3	1.42
CO4	3	3	2	2	1	2	X	X	X	1	1	3	1.50
Average	3.00	3.00	2.25	1.50	1.25	2.00	0.00	0.00	0.25	1.00	1.00	2.75	

Basics of Mathematics and Statistics **COURSE CODE: 20MS1MA111** **L-T-P: 2-0-0** Credits 2	**Course objective** The objective of this course is to give conceptual exposure of essential contents of mathematics and statistics to students for application in biological sciences	**Students Learning Outcomes** On completion of this course, students should be able to: ▪ Gain broad understanding in mathematics and statistics; ▪ Recognize importance and value of mathematical and statistical thinking, training, and approach to problem solving, on a diverse variety of disciplines.

Unit I Algebra 8 lectures	Linear equations, functions: slopes-intercepts, forms of two-variable linear equations; constructing linear models in biological systems; quadratic equations (solving, graphing, features of, interpreting quadratic models *etc*.), introduction to polynomials, graphs of binomials and polynomials; Symmetry of polynomial functions, basics of trigonometric functions, Pythagorean theory, graphing and constructing sinusoidal functions, imaginary numbers, complex numbers, adding-subtracting-multiplying complex numbers, basics of vectors, introduction to matrices.
Unit II Calculus 6 lectures	Differential calculus (limits, derivatives), integral calculus (integrals, sequences and series *etc*.).
Unit III Mathematical models in biology 6 lectures	Population dynamics; oscillations, circadian rhythms, developmental patterns, symmetry in biological systems, fractal geometries, size-limits & scaling in biology, modelling chemical reaction networks and metabolic networks.
Unit IV Statistics 8 lectures	Probability: counting, conditional probability, discrete and continuous random variables; Error propagation; Populations and samples, expectation, parametric tests of statistical significance, nonparametric hypothesis tests, linear regression, correlation & causality, analysis of variance, factorial experiment design.

Recommended Textbooks and References:

1. Stroud, K. A., & Booth, D. J. (2009). *Foundation Mathematics*. New York, NY: Palgrave Macmillan.
2. Aitken, M., Broadhursts, B., & Haldky, S. (2009) *Mathematics for Biological Scientists*. Garland Science.
3. Billingsley, P. (1986). *Probability and Measure.* New York: Wiley.
4. Rosner, B. (2000). *Fundamentals of Biostatistics*. Boston, MA: Duxbury Press.
5. Daniel, W. W. (1987). *Biostatistics, a Foundation for Analysis in the Health Sciences*. New York: Wiley.

CAD Algorithms for Synthesis of Digital Systems

COURSE CODE: XXXXXXX

COURSE CREDITS: 3

CORE/ELECTIVE: Elective

L-T-P: 3-0-0

Pre-requisite: Digital Electronics Course

Objectives:

1. To learn modern techniques and algorithms for synthesis and optimization of digital systems.
2. To provide the basic exposure of technology mapping.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Able to understand the design flow for the implementation of the of digital systems hardware design.	Familiarity
CO-2	Able to understand the concept of optimization in logic synthesis	Usage
CO-3	Able to understand the concept of optimization in Multi level logic synthesis and sequential logics.	Usage
CO-4	Able to understand the algorithm for Boolean decomposition	Usage
CO-5	Able to use the CAD tools for the synthesis of digital systems	Assessment

Course Contents:

S. No.	Contents	Contact Hours
1.	Introduction: Intro to VLSI CAD & Logic Synthesis, Graph Theory & Optimization problems, Boolean Algebra, Boolean Function Representation & Manipulation: BDDs, Satisfiability & Graph Covering	06
2	Exact & Heuristic Two-Level Logic Minimization: SOP & POS forms: Costs & Characteristics, Implicants, Cubes and Covers, Quine-McCluskey Method, Minimum Cover via Unate Covering, Branch-and-Bound Methods, Multi-Output Function Minimization, Unate Recursive Paradigm ,The ESPRESSO Minimizer	06
3	Multi-Level Logic Synthesis - Algebraic Techniques: Combinational Network Representation and Transformations , Factored Forms and Algebraic Techniques Alegbraic Division: Kernels and Co-Kernals, Heuristic Factoring Algorithms, The MIS MODEL	08
4	Boolean Decomposition: Functional Decomposition – Basics, Ashenhurst-Curtis Decomposition, BDS and Bi-Decomposition, Don't Care Conditions & Their Computations, BDD-Based Boolean Decomposition 2, Decomposition for FPGAs • New Logic Synthesis approaches based on AND-Invert Graphs and Boolean Decomposition , The ABC Synthesis & Verification tool	08

5	Delay Optimization: Timing Analysis – Basics, False Path Analysis, Circuit Restructuring for Timing Optimization, Redundancy and Delay: KMS Algorithm Sequential Logic Optimization Finite State Machine Minimization, Two-Level Encoding: DIET & NOVA , Multi-Level Encoding: JEDI, Retiming of Sequential Circuits, Retiming, Resynthesis and Don't Cares Technology Mapping: Tree & DAG Covering, Standard Cell Mapping ,And-Invert Graphs ,Tech-mapping on FPGAs New Directions in Logic Synthesis : Limitations of Conventional Synthesis Tools, Multi-Valued Logic Synthesis, Reversible & quantum logic .	14
	Total	42

Suggested Text Book(s):

1. J. Bhasker, "Verilog VHDL synthesis: a practical primer", B S Publications, 1998.
2. Sait, S. M. and Youssef, Habib, VLSI Physical Design Automation – Theory and Practice, World Scientific, 2004.
3. Sherwani, N., Algorithms for VLSI Physicsl Design Automation, Springer. Third Ed. 2005.
4. Deba Prasad Das, VLSI design, Second Edition, Oxford Publishers, 2015
5. Micheli, Giovanni De. Synthesis and optimization of digital circuits. McGraw-Hill Higher Education, 1994.

Suggested Reference Book(s):

1. S. Ramachandran, "Digital VLSI systems design", Springer, 2007.
2. R.H. Katz, "Contemporary logic design", Addison-Wesley Pub. Co., 1993.
3. M.J.S. Smith, "Application-specific integrated circuits", Addison-Wesley Pub. Co., 1997.
4. M.L. Bushnell and V.D. Agrawal, "Essentials of Electronic Testing", Kluwer Academic Publishers, 2000.
5. D.D. Gajski, N.D. Dutt, A.C. Wu and A.Y. Yin, "High-level synthesis: introduction to chip and system design", Kluwer Academic Publishers, 1992.
6. Andrew B. Kahng, J. Lienig I. L. Markov,J. Hu, VLSI Physical Design: From Graph Partitioning to Timing Closure, Springer, 2011.

Other useful resource(s):

1. http://www.facweb.iitkgp.ac.in/~isg/CAD/SLIDES/01-intro.pdf
2. http://jjackson.eng.ua.edu/courses/ece380/lectures/LECT06.pdf
3. https://canvas.instructure.com/courses/1066166/modules
4. http://www.cs.columbia.edu/~cs6861/handouts/syllabus.pdf
5. https://my.ece.utah.edu/~kalla/ECE5740/syllabus.pdf
6. http://unina.stidue.net/Architettura%20dei%20Sistemi%20di%20Elaborazione/Materiale/G.%20De%20Micheli%20%20Synthesis%20And%20Optimization%20Of%20Digital%20Circuits%20%28Text%20Recognized%20Using%20OCR%29%20%5Bv.%201.03%2020-4-2005%5D.pdf

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered up to T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (CAD Algorithms for Synthesis of Digital Systems)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	3	2	2	3	3	3	3	3	3	3	2.8
CO-2	3	3	3	3	3	3	3	3	3	3	2	2	2.8
CO-3	3	3	3	3	2	2	2	3	2	3	3	2	2.6
CO-4	3	2	3	3	3	3	2	2	3	2	3	3	2.7
CO-5	3	3	3	3	3	3	3	3	3	3	3	3	3
Average	3	2.8	3	2.8	2.6	2.8	2.6	2.8	2.8	2.8	2.8	2.6	

Communication Engineering

COURSE CODE: 18B1WEC535

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Signals & Systems, Basic Course in Probability.

Course Objectives:

1. To understand the use of communication in the field of satellites and the concept of spread spectrum.
2. To make the students familiar with the implications of laws of information theory and coding with reference to the application in communication engineering.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Students will be familiar with the various fields/trends of communications like Satellite communication, Information theory and coding, and spread spectrum technique related to radio and telecommunication.	Familiarity
CO-2	To analyze the error performance of digital modulation systems in the presence of noise.	Assessment
CO-3	Design link power budget for satellite communication.	Assessment
CO-4	Design the channel based on given constraint using information theory.	Assessment
CO-5	Apply various codes like linear block codes, convolution codes etc. for channel performance analysis.	Usage
CO-6	Analyze the performance of spread spectrum systems in jamming environment.	Assessment

Course Contents:

Unit	Contents	Lectures required
1	Introduction to Baseband Transmission and Pass band Digital Modulation: Matched Filter, Inter Symbol Interference, Eye Pattern, Overview of ASK, FSK, PSK, and QAM, Basics of MSK, Signal Constellations, Probability of error analysis of modulation schemes.	6
2	Communication Link Analysis: The Channel, Error-Performance Degradation, Sources of Signal Loss and Noise, Received Signal Power and Noise Power, Link Budget Analysis, Noise Figure, Noise Temperature, System temperature, Sample Link Analysis.	9
3	Fundamental Limits in Information Theory: Uncertainty, Information, Entropy, Source-Coding Theorem, Data Compaction, Discrete Memoryless Channels, Mutual Information, Channel Capacity, Channel-Coding Theorem.	9
4	Error-Control Coding: Introduction, Linear Block Codes, Syndrome, Syndrome Decoding, Cyclic Codes, Generator Polynomial, Parity-Check Polynomial, Convolution Codes, Code tree, Trellis Diagram, Maximum Likelihood Decoding of Convolution Codes, Viterbi Algorithm.	10
5	Spread-Spectrum Modulation: Introduction, Pseudo-Noise Sequences, Direct Sequence Spread Spectrum with coherent BPSK, Signal-Space Dimensionality and Processing Gain, Frequency Hopping Spread Spectrum.	8
Total lectures		42

Suggested Text Book(s):

1. Simon Haykin, "Communication Systems", 4th Ed., John Wiley & Sons, 2004.
2. Bernard Sklar and P. K. Ray, "Digital Communications: Fundamentals and Applications", 2nd Ed., Pearson Education, 2012.

Suggested Reference Book(s):

1. B. P. Lathi and Zhi Ding, "Modern Digital and Analog Communication Systems", 4th Ed., Oxford, 2010.

Other useful resource(s):

Link to NPTEL course contents: https://nptel.ac.in/courses/117105131/16
Link to NPTEL course contents: https://nptel.ac.in/courses/117101053/1
Link to NPTEL course contents: https://nptel.ac.in/courses/117105136/1

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (1) - 5 Quizzes (2) - 15 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course Outcomes (Communication Engineering)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	3	3	1	2	1	2	1	2	2	3	2.17
CO-2	3	3	3	3	3	2	2	2	1	1	1	3	2.25
CO-3	3	3	3	3	2	3	3	2	1	2	3	3	2.58
CO-4	3	3	3	2	2	1	1	1	1	2	3	3	2.08
CO-5	3	3	3	2	3	2	1	2	1	2	3	3	2.33
CO-6	3	3	2	2	2	3	3	2	2	3	3	3	2.58
Average	3.00	3.00	2.83	2.50	2.17	2.17	1.83	1.83	1.17	2.00	2.50	3.00	

Cognitive Radio Networks

COURSE CODE: 18B1WEC849

COURSE CREDITS: 3

CORE/ELECTIVE: Elective

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

1. To understand the principles, applications and challenges of cognitive radio technology.
2. Analyze the design of wireless networks based on cognitive radio technology.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Understand the fundamental issues regarding dynamic spectrum access and radio-resource management.	Familiarity
CO-2	Analyze the emerging issues in cognitive radio network.	Assessment
CO-3	Apply different spectrum sharing models in the Cognitive Radio Network.	Assessment
CO-4	Apply efficient sharing of the unutilized spectrum among cognitive and licensed users while avoiding interference to the licensed user due to cognitive user's transmission	Usage

Course Contents:

Unit	Contents	Lectures required
1	Introduction to Cognitive Radio: Spectrum scarcity, Spectrum white space, Fixed spectrum allocation, Software defined radio (SDR), Limitations of SDR, Evolution of cognitive radio, Dynamic spectrum access, Introduction to cognitive radio concept, Cognitive cycle, Functions of cognitive radio; spectrum sensing, spectrum management, spectrum mobility, Cognitive radio architecture, Interference temperature and its models.	8
2	Spectrum Sensing and Challenges in Cognitive Radio Network: Hypothesis model for spectrum sensing, Types of spectrum sensing; Non-cooperative sensing, Cooperative sensing, Interference-based sensing, Matched filter detection, Energy detection, Cyclostationary feature detection, advantages and disadvantages of various spectrum sensing techniques, False alarm, Miss detection, Optimal sensing framework for infrastructure based cognitive radio network. Research challenges in spectrum sensing, spectrum management and spectrum mobility, potential applications of cognitive radio, IEEE 802.22 for WRANs	8
3	Spectrum Sharing and Management: Dynamic spectrum Access (DSA): models and architectures, Opportunistic spectrum access (OSA), Antenna Systems, MIMO systems, Smart antenna and beamforming. SDR architecture, Software tunable analog radio components, Reconfigurable digital radio technologies.	8
4	Cross Layer Adaptation and Security in Cognitive Radio: Why we need cross-layer design, adaptation and optimization, Cognitive radio cross layer design, security challenges in cognitive radio. OFDM for Cognitive Radio: OFDM based cognitive radio, Why OFDM is a good fit for Cognitive radio, Challenges to cognitive OFDM systems, Multiband OFDM, A step toward cognitive-OFDM: standards and technologies.	9
5	Cognitive Radio Regulation and Standardization: regulatory issues and new spectrum management regimes, spectrum planning, Spectrum authorization, Standards and international activities. UWB Cognitive Radio: Introduction, Fundamentals of impulse radio Ultra Wideband, Cognitive radio requirements versus IR-UWB, Merging impulse radio with cognitive radio.	9
Total lectures		42

Suggested Text Book(s):

1. Ekram Hossain, Dusit Niyato and Zhu Han: Dynamic Spectrum Access and Spectrum Management in Cognitive Radio Networks, 1st Edition, Cambridge University Press, 2009.
2. Huseyin Arslan: Cognitive Radio, Software Defined Radio, and Adaptive Wireless Systems, 1st Edition, Springer, 2007.
3. Bruce A. Fette: Cognitive Radio Technology, 2nd Edition, Academic Press, April 6, 2009.

Suggested Reference Book(s):

1. Yang Xiao and Fei Hu: Cognitive Radio Networks, 1st Edition, CRC Press, 2008.
2. Linda E. Doyle: Essentials of Cognitive Radio, 1st Edition, Cambridge University Press, 2009.

Other useful resource(s):

Link to GIAN IIT Kanpur course contents (10 lecture series):
https://www.youtube.com/watch?v=SljXFf0vgvw&list=PL48UwQJyfW3SmrjLgl5LrVciqfWz9XazY

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Cognitive Radio Networks)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	2	2	2	2	1	2	1	2	2	3	2.08
CO-2	3	3	3	3	2	1	1	1	2	2	1	2	2
CO-3	3	3	3	2	2	2	1	2	2	2	1	3	2.17
CO-4	3	3	3	3	2	1	1	1	2	3	2	3	2.25
Average	3	3	2.75	2.5	2	1.5	1	1.5	1.75	2.25	1.5	2.75	

Recommended Textbooks and References:

1. Rajagopal Vadivambal, Digvir S. Jayas. (2015). *Bio-Imaging: Principles, Techniques, and Applications*. ISBN 9781466593671 -CAT# K20618.
2. Alberto Diaspro, Marc A. M. J. van Zandvoort. (2016). *Super-Resolution Imaging in Biomedicine*. ISBN 9781482244342 -CAT# K23483.
3. Taatjes, Douglas, Roth, Jürgen (Eds.). (2012). *Cell Imaging Techniques Methods and Protocols*. ISBN 978-1-62703-056-4.

Computational Biology

Credits

2

Course Objectives

The objective of this course is to provide students with theory and practical experience of essentials to aid for genomic, proteomic and metabolomics courses and drug design program.

Student Learning Outcomes

On completion of this course, the students are expected to:

- Develop an understanding of the basic theory of these computational tools;
- Develop required database extraction, integration, coding for computational tools and methods necessary for all Omics;
- Create hypothesis for investigating specific contemporary biological questions, provide help to experiment with or develop appropriate tools;
- Critically analyze and interpret results of their study with respect to whole systems.

Unit I

Introduction to computational biology basics and biological databases

4 lectures

Computers in biology and medicine; Overview of biological databases, nucleic acid & protein databases, primary, secondary, functional, composite, structural classification database, Sequence formats & storage, Access databases, Extract and create sub databases, limitations of existing databases.

Unit II

Pairwise and multiple sequence alignments

5 lectures

Local alignment, Global alignment, Scoring matrices - PAM, BLOSUM, Gaps and penalties, Dot plots. Dynamic programming approach: Needleman and Wunsch Algorithm, Smith and Waterman Algorithm, Hidden Markov Model: Viterbi Algorithm. Heuristic approach: BLAST, FASTA. Building Profiles, Profile based functional identification.

Unit III

Genome analysis

6 lectures

Polymorphisms in DNA sequence, Introduction to Next Generation Sequencing technologies, Whole Genome Assembly and challenges, Sequencing and analysis of large genomes, Gene prediction, Functional annotation, Comparative genomics, Probabilistic functional gene networks, Human genome project, Genomics and crop improvement. Study available GWAS, ENCODE, HUGO projects, extract and build sub databases; Visualization tools including Artemis and Vista for genome comparison; Functional genomics case studies.

Unit IV

Structure visualization

3 lectures

Retrieving and drawing structures, Macromolecule viewing platforms, Structure validation and correction, Structure optimization, Analysis of ligand-protein interactions; Tools such as PyMol or VMD.

Unit V

Molecular modelling

6 lectures

Significance and need, force field methods, energy, buried and exposed residues; side chains and neighbours; fixed regions; hydrogen bonds; mapping properties onto surfaces; RMS fit of conformers and protein chains, assigning secondary structures; sequence alignment: methods, evaluation, scoring; protein curation: backbone construction and side chain addition; different types of protein chain modelling: ab initio, homology, hybrid, loop; Template recognition and alignments; Modelling parameters and considerations; Model analysis and validation; Model optimization; Substructure manipulations, annealing, protein folding and model generation; loop generating methods; loop analysis; Analysis of active sites using different methods in studying protein–protein interactions.

Unit VI

Structure-based drug development

6 lectures

Molecular docking: Types and principles, Semi-flexible docking, Flexible docking; Ligand and protein preparation, Macromolecule and ligand optimization, Ligand conformations, Clustering, Analysis of docking results and validation with known information. Extra-precision docking platforms, Use of Small-molecule libraries, Natural compound libraries for virtual high throughput screenings.

Unit VII

Ligand-based drug development

6 lectures

Quantitative structure activity relationships; Introduction to chemical descriptors like 2D, 3D and Group-based; Radar plots and contribution plots and Activity predictions, Pharmacophore modeling, Pharmacophore-based screenings of compound library, analysis and experimental validation.

Recommended Textbooks and References:

1. Mount, D. W. (2001). *Bioinformatics: Sequence and Genome Analysis*. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.
2. Bourne, P. E., & Gu, J. (2009). *Structural Bioinformatics*. Hoboken, NJ: Wiley-Liss.
3. Lesk, A. M. (2004). *Introduction to Protein Science: Architecture, Function, and Genomics*. Oxford: Oxford University Press.
4. Campbell, M & Heyer, L. J. (2006), *Discovering Genomics, Proteomics and Bioinformatics*, Pearson Education.
5. Oprea, T. (2005). *Chemoinformatics in Drug Discovery*, Volume 23. Wiley Online Library.
6. Gasteiger, J. & Engel, T. (2003), *Chemoinformatics: a Textbook*, Wiley Online Library.

Drug Discovery and Development

Credits

2

Course Objectives

This course will give a broad overview of research and development carried out in industrial setup towards drug discovery.

Student Learning Outcomes

On completion of this course, students should be able to understand basics of R&D in drug discovery and should be able to apply knowledge gained in respective fields of pharmaceutical industry.

Unit I

Target identification and molecular modelling

7 lectures

Identification of target or drug leads associated with a particular disease by a number of different techniques including combinations of molecular modeling, combinatorial libraries and high-throughput screening (HTS); Conceptualizing the automation of the HTS process and the importance of bioinformatics and data processing in identification of lead compounds; Rational drug design, based on understanding the three-dimensional

Computer Vision

COURSE CODE: XXXXXXXX

COURSE CREDITS: XX

CORE/ELECTIVE: XX

: XX

Pre-requisite: Prerequisites are some prior knowledge to computer vision, machine learning and image processing. Student should have a basic level of expertise in programming, computer science, and mathematics.

Course Objectives:

1. To implement fundamental image processing techniques required for computer vision.
2. Understand image formation process.
3. Extract features form Images and generate 3D model from images.
4. To study State of the Art algorithms with engineering applications.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Theoretical and practical aspects of computing with images	Familiarity
CO-2	The foundation of image formation and image analysis	Assessment
CO-3	Understand the basics of 2D and 3D Computer Vision	Assessment
CO-4	Study of computer vision applications	Usage

Course Contents:

Unit	Contents	Lectures required
1	Introduction : Image Processing, Computer Vision and Computer Graphics Overview of Diverse Computer Vision Applications: Document Image Analysis, Biometrics, Object Recognition, Tracking, Medical Image Analysis, Content-Based Image Retrieval, Video Data Processing, Multimedia, Virtual Reality and Augmented Reality	8
2	Image Formation Models : The 'Physics' of Image Formation, Radiance, Irradiance, BRDF, color etc, Camera model and Camera calibration, Binocular imaging systems, Multiple views geometry, Structure determination, shape from shading, Photometric Stereo, Depth from Defocus, Construction of 3D model from images	8
3	Feature Extraction and Motion Estimation: Image preprocessing, Image representations (continuous and discrete), Edge detection, Regularization theory, Stereo Vision, Motion estimation, Structure from motion	7

4	Shape Representation and Segmentation : Contour based representation, Region based representation, Deformable curves and surfaces, Snakes and active contours, Level set representations, Fourier and wavelet descriptors, Multi resolution analysis	7
5	Object recognition: Hough transforms and other simple object recognition methods, Shape correspondence and shape matching, Principal component analysis, Singular value decomposition.	6
6	Applications: Face detection, Face recognition, Eigen faces, Active appearance and 3D shape models of faces Application, Applications range from Biometrics, Medical diagnosis, document processing, mining of visual content, to surveillance, advanced rendering etc.	6
Total lectures		42

Suggested Text Book(s):

1. D. Forsyth and J. Ponce, "Computer Vision - A modern approach, by ", Prentice Hall
2. B. K. P. Horn, "Robot Vision", McGraw-Hill.
3. R. C. Gonzalez, R. E. Woods, " Digital Image Processing" Addison Wesley Longman, Inc., 1992
4. D. H. Ballard, C. M. Brown, "Computer Vision", Prentice-Hall, Englewood Cliffs, 1982.

Suggested Reference Book(s):

1. Simon J. D. Prince, "Computer Vision: Models, Learning, and Inference", Cambridge University Press, 2012
2. Mark Nixon and Alberto S. Aquado, "Feature Extraction & Image Processing for Computer Vision", Third Edition, Academic Press, 2012.

Other useful resource(s):

1. Computer Vision. Ballard and Brown
2. Invitation to 3D Vision: From Images to Geometric Models: Y. Ma, S. Soatto, J. Kosecka and S. Sastry
3. https://nptel.ac.in/noc/courses/noc19/SEM2/noc19-cs58/
4. https://www.tutorialspoint.com/dip/computer_vision_and_graphics.htm

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Computer Vision)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	3	3	2	1	1	1	2	2	2	2	1.91
CO-2	3	3	3	3	3	2	1	1	3	2	1	3	2.33
CO-3	2	3	2	2	2	2	2	2	2	2	1	2	2.00
CO-4	3	3	3	3	2	1	1	1	2	3	2	3	2.25
Average	2.50	2.75	2.75	2.75	2.25	1.50	1.25	1.25	2.25	2.25	1.50	2.50	

Digital CMOS ICs

COURSE CODE: _____

COURSE CREDITS: 3

CORE/ELECTIVE: PROFIENCY

: 3-4-0

Pre-requisite: VLSI Technology

(18B11EC612) Course Objectives:

1. To understand and learn to use CMOS in designing combinational circuits, sequential circuits, semiconductor memories including the design of arithmetic building blocks.
2. To learn various low power CMOS logic design techniques including the clock and IO circuits design issues.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	To understand the MOS transistor as inverter, switch, its capacitance and CMOS logic gate design.	Familiarity
CO-2	To be able design and analyze combinational and sequential CMOS circuits and tradeoffs	Usage
CO-3	Able to design circuits using dynamic logic design technique	Usage, Assessment
CO-4	To understand and use the low power design techniques, methodologies and design practices to reduce the power dissipation of large scale CMOS digital ICs.	Assessment
CO-5	To understand the manufacturability and testability issues to be considered during the design phase of an IC	Familiarity

Course Contents:

Unit	Contents	Lectures required
1	Introduction to CMOS and its working as an inverter, review of delay time definitions, interconnect delay, switching power dissipation, sizing trends in CMOS inverter, delay constraints, MOSFETs, capacitances	5
2	Combinational logic circuits: Logic circuits with Pseudo-nMOS loads, CMOS Logic circuits, Complex logic circuits, CMOS Transmission Gates (Pass Gates)	5
3	Sequential Logic circuits: Behavior of bi-stable elements, SR Latch circuits, clocked latch and flip-flop circuits, clocked storage elements- timing parameters, CMOS D-latch and edge triggered Flip-Flop, Pulsed latch based clocked storage elements, Sense amplifier based Flip-Flops, Logic Embedding in clocked storage elements, Power consumption of clocking system and power saving methodologies.	11

4	Dynamic Logic circuits: Basic pass transistor circuits, voltage bootstrapping, synchronous dynamic circuit design techniques, Dynamic CMOS circuit design techniques, High performance Dynamic CMOS circuits	4
5	Dynamic Random access memory(DRAM), static random access memory (SRAM), Nonvolatile memory, Flash memory, Ferroelectric Random access memory (FRAM)	3
6	Low power CMOS Logic circuits: sources of power consumption, low power design through voltage scaling, estimation and optimization of switching activity, reduction of switched capacitance, adiabatic logic circuits	6
7	Design for manufacturability and testability: ESD protection, input circuits, output circuits and noise, On chip clock generation and distribution, latch-up and its prevention, process variations, design of experiments and performance modeling, parametric yield estimation, worst case analysis, performance variability minimization, fault types and models controllability and observability, adhoc testable design techniques, scan based techniques, built in self test (BIST), current monitoring tests	8
Total lectures		42

Suggested Text Book(s):

1. Sung-Mo Kang, Yusuf Leblebici, Chulwoo Kim: CMOS Digital Integrated Circuits Analysis and Design, fourth edition, Tata McGraw-Hill, 2016.
2. Thomas A. Demassa, Zack Ciccone: Digital Integrated Circuits, John Wiley & Sons (Asia) Pte., Ltd.
3. John P. Uyemura: Introduction to VLSI Circuits and Systems, John Wiley & Sons, Inc., 2002.

Suggested Reference Book(s):

1. Kaushik Roy, Sharat Prasad: Low power CMOS VLSI circuit Design, Wiley India, 2010.
2. Adel S. Sedra, Kenneth C. Smith: Microelectronics Circuits, 5th Ed., Oxford University, 2004.

Other useful resource(s):

1. Link to NPTEL course contents: https://nptel.ac.in/courses/108106069/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Class performance, Tutorials & Assignments - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Digital CMOS ICs)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO1	3	3	2	3	2	2	2	1	1	1	2	3	2.08
CO2	3	3	3	2	2	2	2	1	1	2	1	3	2.08
CO3	3	3	3	3	3	2	1	1	1	1	1	2	2
CO4	3	3	3	3	3	3	1	1	1	1	1	2	2.08
CO5	3	2	2	2	3	2	1	1	1	1	1	2	1.75
CO6	3	3	3	3	3	3	3	1	1	1	1	3	2.33
Average	3.00	2.83	2.67	2.67	2.67	2.33	1.67	1	1	1.17	1.17	2.50	

Unit V

Molecular modelling

6 lectures

Significance and need, force field methods, energy, buried and exposed residues; side chains and neighbours; fixed regions; hydrogen bonds; mapping properties onto surfaces; RMS fit of conformers and protein chains, assigning secondary structures; sequence alignment: methods, evaluation, scoring; protein curation: backbone construction and side chain addition; different types of protein chain modelling: ab initio, homology, hybrid, loop; Template recognition and alignments; Modelling parameters and considerations; Model analysis and validation; Model optimization; Substructure manipulations, annealing, protein folding and model generation; loop generating methods; loop analysis; Analysis of active sites using different methods in studying protein–protein interactions.

Unit VI

Structure-based drug development

6 lectures

Molecular docking: Types and principles, Semi-flexible docking, Flexible docking; Ligand and protein preparation, Macromolecule and ligand optimization, Ligand conformations, Clustering, Analysis of docking results and validation with known information. Extra-precision docking platforms, Use of Small-molecule libraries, Natural compound libraries for virtual high throughput screenings.

Unit VII

Ligand-based drug development

6 lectures

Quantitative structure activity relationships; Introduction to chemical descriptors like 2D, 3D and Group-based; Radar plots and contribution plots and Activity predictions, Pharmacophore modeling, Pharmacophore-based screenings of compound library, analysis and experimental validation.

Recommended Textbooks and References:

1. Mount, D. W. (2001). *Bioinformatics: Sequence and Genome Analysis*. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.
2. Bourne, P. E., & Gu, J. (2009). *Structural Bioinformatics*. Hoboken, NJ: Wiley-Liss.
3. Lesk, A. M. (2004). *Introduction to Protein Science: Architecture, Function, and Genomics*. Oxford: Oxford University Press.
4. Campbell, M & Heyer, L. J. (2006), *Discovering Genomics, Proteomics and Bioinformatics*, Pearson Education.
5. Oprea, T. (2005). *Chemoinformatics in Drug Discovery*, Volume 23. Wiley Online Library.
6. Gasteiger, J. & Engel, T. (2003), *Chemoinformatics: a Textbook*, Wiley Online Library.

Drug Discovery and Development

Credits

2

Course Objectives

This course will give a broad overview of research and development carried out in industrial setup towards drug discovery.

Student Learning Outcomes

On completion of this course, students should be able to understand basics of R&D in drug discovery and should be able to apply knowledge gained in respective fields of pharmaceutical industry.

Unit I

Target identification and molecular modelling

7 lectures

Identification of target or drug leads associated with a particular disease by a number of different techniques including combinations of molecular modeling, combinatorial libraries and high-throughput screening (HTS); Conceptualizing the automation of the HTS process and the importance of bioinformatics and data processing in identification of lead compounds; Rational drug design, based on understanding the three-dimensional

structures and physicochemical properties of drugs and receptors; Modelling drug/receptor interactions with the emphasis on molecular mechanisms, molecular dynamics simulations and homology modelling; Conformational sampling, macromolecular folding, structural bioinformatics, receptor-based and ligand-based design and docking methods, in silico screening of libraries, semi-empirical and ab-initio methods, QSAR methods, molecular diversity, design of combinatorial libraries of drug-like molecules, macromolecular and chemical databases.

Unit II
Lead optimization
5 lectures

Identification of relevant groups on a molecule that interact with a receptor and are responsible for biological activity; Understanding structure activity relationship; Structure modification to increase potency and therapeutic index; Concept of quantitative drug design using Quantitative structure–activity relationship models (QSAR models) based on the fact that the biological properties of a compound are a function of its physicochemical parameters such as solubility, lipophilicity, electronic effects, ionization, stereochemistry, *etc.*; Bioanalytical assay development in support of *in vitro* and *in vivo* studies (LC/MS/MS, GC/MS and ELISA).

Unit III
Preclinical development
5 lectures

Principles of drug absorption, drug metabolism and distribution - intestinal absorption, metabolic stability, drug-drug interactions, plasma protein binding assays, metabolite profile studies, Principles of toxicology, Experimental design for preclinical and clinical PK/PD/TK studies, Selection of animal model; Regulatory guidelines for preclinical PK/PD/TK studies; Scope of GLP, SOP for conduct of clinical & non clinical testing, control on animal house, report preparation and documentation Integration of non-clinical and preclinical data to aid design of clinical studies.

Unit IV
Drug manufacturing
4 lectures

Requirements of GMP implementation, Documentation of GMP practices, CoA, Regulatory certification of GMP, Quality control and Quality assurance, concept and philosophy of TQM, ICH and ISO 9000; ICH guidelines for Manufacturing, Understanding Impurity Qualification Data, Stability Studies.

Unit V
Clinical trial design
4 lectures

Objectives of Phase I, II, III and IV clinical studies, Clinical study design, enrollment, sites and documentation, Clinical safety studies: Adverse events and adverse drug reactions, Clinical PK, pharmacology, drug-drug interaction studies, Statistical analysis and documentation.

Unit VI
Fundamentals of regulatory affairs and bioethics
4 lectures

Global Regulatory Affairs and different steps involved, Regulatory Objectives, Regulatory Agencies; FDA guidelines on IND and NDA submissions, Studies required for IND and NDA submissions for oncology, HIV, cardiovascular indications, On-label *vs.* off-label drug use GCP and Requirements of GCP Compliance, Ethical issues and Compliance to current ethical guidelines, Ethical Committees and their set up, Animal Ethical issues and compliance.

Recommended Textbooks and References:

1. Krogsgaard-Larsen *et al. Textbook of Drug Design and Discovery*. 4th Edition. CRC Press.
2. Kuhse, H. (2010). *Bioethics: an Anthology*. Malden, MA: Blackwell.
3. Nally, J. D. (2006) *GMP for Pharmaceuticals*. 6th edition. CRC Press
4. Brody, T. (2016) *Clinical Trials: Study Design, Endpoints and Biomarkers,* Drug Safety, and FDA and ICH Guidelines. Academic Press.

Design of Modern Antennas

COURSE CODE: 18B1WEC852

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Transmission lines and E.M waves.

Course Objectives:

The main objective of the course is to

1. Learn the mechanism of antenna, antenna performance parameters.
2. Design and analysis of various antennas for different applications.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	To define overall needs and constraints of RF systems and antennas.	Familiarity
CO-2	To understand the mechanism of antenna radiation.	Familiarity
CO-3	To design and analyze various antennas for specific application.	Usage
CO-4	Size reduction techniques, Broad banding and multi band operation techniques in antenna design.	Usage
CO-5	Evaluate the opportunities involving technology, a product or a service required for developing a startup idea.	Assessment

Course Contents:

Unit	Contents	Lectures required
1.	Introduction: antenna types, radiation mechanism, use of potential functions, radiated field, far field, antenna parameters, radiation pattern, directivity, numerical evaluation of directivity, gain, efficiency, impedance, loss resistance, polarization, linear polarization, circular and elliptic polarization, equivalent area, Friss equation.	6
2.	Dipole Antennas: Potential functions for analysis of radiated fields, Duality theorem, Reciprocity theorem for antennas, Radiation from current element, infinitesimal dipole, finite length dipole, half wave dipole	6
3.	Antenna Arrays: Analysis and Synthesis Review of antenna array basics, Linear arrays, circular array, planar (2D) arrays, sum and difference patterns, Effect of mutual couplings, Phased array antennas, scan Principles, Non uniform arrays, Dolph Chebyshev Arrays Binomial Arrays.	6
4	Broadband and Frequency Independent Antennas Helical antenna: Normal mode and axial mode helix Spiral antennas, Log Periodic antennas.	5
5.	Aperture Antennas Radiation from an aperture in an infinite ground plane, Radiation from rectangular and circular apertures, Radiation from a slotted rectangular waveguide Horn antenna: E plane and H plane sectoral horns, Pyramidal horn, Conical horn Reflector antennas parabolic reflector, methods of analysis, dual reflector antennas, offset reflector antenna, gain and efficiency calculations, scanning properties and cross polarization Lens antennas and their applications	7
6	Microstrip Antennas Rectangular patch antenna: cavity and transmission line models, Circular patch antenna Coupling mechanisms, circular polarization, Microstrip arrays, Broadband and Multi band microstrip antennas, Compact Microstrip Antennas.	7
7	Dielectric Resonator Antennas Introduction, radiation mechanism, advantages of DRA, types of DRA, feeding techniques, design method, modes.	5
Total lectures		42

Suggested Text Book(s):

1. Constantine A. Balanis: Antenna Theory Analysis and Desin, John Wiley, 3rd Edition, 2009.
2. Antennas for All Applications, J. D. Kraus and R. J. Marhefka, McGraw-Hill, Inc, 3rd Ed., 2007.

3. Rectangular Dielectric Resonator Antennas, Rajveer S. Yaduvanshi Harish Parthasarathy, Springer, 1st Ed, 2016.

Suggested Reference Book(s):

1. Antennas and Radio wave Propagation, R. E. Collin, McGraw-Hill, Inc, 3rd Ed, 2005.
2. Modern Antenna Design, T. A. Milligan, John Wiley & Sons, 2nd Ed., 2005.
3. Antenna Arrays, R. L. Haupt, John Wiley & Sons, Inc., 1st Ed., 2010.
4. Antenna Theory and Microstrip Antennas, D. G. Fang, CRC Press, 1st Ed., 2009.

Other useful resource(s):

Link to NPTEL course contents

1. https://nptel.ac.in/courses/108101092/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered up to T-1
2	T-2	25	1.5 Hours	Syllabus covered up to T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes(2) -10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Design of Modern Antennas)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	3	3	3	2	1	1	1	2	2	2	2.2
CO-2	2	3	3	3	2	2	1	1	2	1	1	2	1.9
CO-3	2	2	2	3	2	2	1	1	1	2	1	3	1.8
CO-4	2	2	3	3	2	1	1	2	2	2	2	2	2
CO-5	2	2	3	3	3	2	1	1	2	2	1	2	2
Average	2.2	2.4	2.8	3	2.4	1.8	1	1.2	1.6	1.6	1.4	2.2	

Environmental Biotechnology

Credits

2

Course Objectives

This course aims to introduce fundamentals of Environmental Biotechnology. The course will introduce major groups of microorganisms-tools in biotechnology and their most important environmental applications. The environmental applications of biotechnology will be presented in detail and will be supported by examples from the national and international literature.

Student Learning Outcomes

On completion of course, students will be able to understand use of basic microbiological, molecular and analytical methods, which are extensively used in environmental biotechnology.

Unit I

Introduction to environment

6 lectures

Introduction to environment; pollution and its control; pollution indicators; waste management: domestic, industrial, solid and hazardous wastes; strain improvement; Biodiversity and its conservation; Role of microorganisms in geochemical cycles; microbial energy metabolism, microbial growth kinetics and elementary chemostat theory, relevant microbiological processes, microbial ecology.

Unit II

Bioremediation

6 lectures

Bioremediation: Fundamentals, methods and strategies of application (biostimulation, bioaugmentation) – examples, bioremediation of metals (Cr, As, Se, Hg), radionuclides (U, Te), organic pollutants (PAHs, PCBs, Pesticides, TNT *etc.*), technological aspects of bioremediation (*in situ, ex situ*).

Unit III

Role of microorganisms in bioremediation

6 lectures

Application of bacteria and fungi in bioremediation: White rot fungi *vs* specialized degrading bacteria: examples, uses and advantages *vs* disadvantages; Phytoremediation: Fundamentals and description of major methods of application (phytoaccumulation, phytovolatilization, rhizofiltration phytostabilization).

Unit IV

Biotechnology and agriculture

11 lectures

Bioinsecticides: *Bacillus thuringiensis*, Baculoviruses, uses, genetic modifications and aspects of safety in their use; Biofungicides: Description of mode of actions and mechanisms (*e.g. Trichoderma, Pseudomonas fluorescens*); Biofertilizers: Symbiotic systems between plants – microorganisms (nitrogen fixing symbiosis, mycorrhiza fungi symbiosis), Plant growth promoting rhizobacteria (PGPR) – uses, practical aspects and problems in application.

Unit V

Biofuels

11 lectures

Environmental Biotechnology and biofuels: biogas; bioethanol; biodiesel; biohydrogen; Description of the industrial processes involved, microorganisms and biotechnological interventions for optimization of production; Microbiologically enhanced oil recovery (MEOR); Bioleaching of metals; Production of bioplastics; Production of biosurfactants: bioemulsifiers; Paper production: use of xylanases and white rot fungi.

Recommended Textbooks and References:

1. G. M. Evans and J. C. Furlong (2003), *Environmental Biotechnology: Theory and Applications*, Wiley Publishers.
2. B. Ritmann and P. L. McCarty, (2000), *Environmental Biotechnology: Principle & Applications*, 2nd Ed., McGraw Hill Science.
3. Scragg A., (2005) *Environmental Biotechnology*. Pearson Education Limited.
4. J. S. Devinny, M. A. Deshusses and T. S. Webster, (1998), *Biofiltration for Air Pollution Control*, CRC Press.
5. H. J. Rehm and G. Reed, (2001), *Biotechnology – A Multi-volume Comprehensive Treatise*, Vol. 11, 2nd Ed., VCH Publishers Inc.

Environmental Biotechnology

Credits

2

Course Objectives

This course aims to introduce fundamentals of Environmental Biotechnology. The course will introduce major groups of microorganisms-tools in biotechnology and their most important environmental applications. The environmental applications of biotechnology will be presented in detail and will be supported by examples from the national and international literature.

Student Learning Outcomes

On completion of course, students will be able to understand use of basic microbiological, molecular and analytical methods, which are extensively used in environmental biotechnology.

Unit I

Introduction to environment

6 lectures

Introduction to environment; pollution and its control; pollution indicators; waste management: domestic, industrial, solid and hazardous wastes; strain improvement; Biodiversity and its conservation; Role of microorganisms in geochemical cycles; microbial energy metabolism, microbial growth kinetics and elementary chemostat theory, relevant microbiological processes, microbial ecology.

Unit II

Bioremediation

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Biofuels

11 lectures

Environmental Biotechnology and biofuels: biogas; bioethanol; biodiesel; biohydrogen; Description of the industrial processes involved, microorganisms and biotechnological interventions for optimization of production; Microbiologically enhanced oil recovery (MEOR); Bioleaching of metals; Production of bioplastics; Production of biosurfactants: bioemulsifiers; Paper production: use of xylanases and white rot fungi.

Recommended Textbooks and References:

1. G. M. Evans and J. C. Furlong (2003), *Environmental Biotechnology: Theory and Applications*, Wiley Publishers.
2. B. Ritmann and P. L. McCarty, (2000), *Environmental Biotechnology: Principle & Applications*, 2nd Ed., McGraw Hill Science.
3. Scragg A., (2005) *Environmental Biotechnology*. Pearson Education Limited.
4. J. S. Devinny, M. A. Deshusses and T. S. Webster, (1998), *Biofiltration for Air Pollution Control*, CRC Press.
5. H. J. Rehm and G. Reed, (2001), *Biotechnology – A Multi-volume Comprehensive Treatise*, Vol. 11, 2nd Ed., VCH Publishers Inc.

5 El-Mansi, M., & Bryce, C. F. (2007). *Fermentation Microbiology and Biotechnology.* Boca Raton: CRC/Taylor & Francis.

Emerging Technologies

Credits

2

Course Objectives

This course is broad-based in nature encompassing several new technologies that current experimental researchers are employing to probe complex system biology questions in life-sciences. The objectives of this course are to teach basics of the new principles to students so as to appreciate current-day research tool-kit better.

Student Learning Outcomes

Students should be to learn history, theoretical basis and basic understanding of latest technologies in area of biotechnology. They should also be able to learn about various applications of these technologies. The students may also learn one application in depth through an assignment and/or seminar.

Unit I
Optical microscopy methods
8 lectures

Basic Microscopy: Light Microscopy: lenses and microscopes, resolution: Rayleigh's Approach, Darkfield; Phase Contrast; Differential Interference Contrast; fluorescence and fluorescence microscopy: what is fluorescence, what makes a molecule fluorescent, fluorescence microscope; optical arrangement, light source; filter sets: excitation filter, dichroic mirror, and barrier, optical layout for image capture; CCD cameras; back illumination, binning; recording color; three CCD elements with dichroic beamsplitters, boosting the signal.

Advanced Microscopy: Confocal microscope: scanning optical microscope, confocal principle, resolution and point spread function, light source: gas lasers & solid-state, primary beamsplitter; beam scanning, pinhole and signal channel configurations, detectors; pixels and voxels; contrast, spatial sampling: temporal sampling: signal-to-noise ratio, multichannel images. nonlinear microscopy: multiphoton microscopy; principles of two-photon fluorescence, advantages of two-photon excitation, tandem scanning (spinning disk) microscopes, deconvolving confocal images; image processing, three-dimensional reconstruction; advanced fluorescence techniques: FLIM, FRET, and FCS, Fluorescence Lifetime, Fluorescence Resonant Energy Transfer (FRET), Fluorescence Correlation Spectroscopy (FCS), Evanescent Wave Microscopy; Near-Field and Evanescent Waves, Total Internal Reflection Microscopy; Near-Field Microscopy; Beyond the Diffraction Limit: Stimulated Emission Depletion (STED), Super-Resolution Summary, Super-Resolution Imaging with Stochastic Optical Reconstruction Microscopy (STORM) and Photoactivated Localization Microscopy (PALM).

Unit II
Mass spectroscopy
4 lectures

Ionization techniques; mass analyzers/overview MS; FT-ICR and Orbitrap, fragmentation of peptides; proteomics, nano LC-MS; Phospho proteomics; interaction proteomics, mass spectroscopy in structural biology; imaging mass spectrometry.

Unit III
Systems biology
3 lectures

High throughput screens in cellular systems, target identification, validation of experimental methods to generate the omics data, bioinformatics analyses, mathematical modeling and designing testable predictions.

Unit IV
Structural biology
3 lectures

X-ray diffraction methods, solution & solid-state NMR, cryo-electron microscopy, small-angle X-ray scattering, Atomic force microscopy.

Unit V
CRISPR-CAS
6 lectures

History of its discovery, elucidation of the mechanism including introduction to all the molecular players, development of applications for *in vivo* genome engineering for genetic studies, promise of the technology as a next generation therapeutic method.

Unit VI

Nanobodies

4 lectures

Introduction to nanobodies, combining nanobody with phage-display method for development of antibody against native proteins, nanobody as a tool for protein structure-function studies, use of nanobodies for molecular imaging, catabolic antibodies using nanobodies.

Recommended Textbooks and References:

1. Campbell, I. D. (2012). *Biophysical Techniques*. Oxford: Oxford University Press.
2. Serdyuk, I. N., Zaccai, N. R., & Zaccai, G. (2007). *Methods in Molecular Biophysics: Structure, Dynamics, Function*. Cambridge: Cambridge University Press.
3. Phillips, R., Kondev, J., & Theriot, J. (2009). P*hysical Biology of the Cell*. New York: Garland Science.
4. Nelson, P. C., Radosavljević, M., & Bromberg, S. (2004). *Biological Physics: Energy, Information, Life*. New York: W.H. Freeman.
5. Huang, B., Bates, M., & Zhuang, X. (2009). *Super-Resolution Fluorescence Microscopy.* Annual Review of Biochemistry, 78(1), 993-1016. doi:10.1146/annurev.biochem.77.061906.092014.
6. Mohanraju, P., Makarova, K. S., Zetsche, B., Zhang, F., Koonin, E. V., & Oost, J. V. (2016). *Diverse Evolutionary Roots and Mechanistic Variations of the CRISPR-Cas Systems.* Science, 353(6299). doi:10.1126/science.aad5147.
7. Lander, E. (2016). *The Heroes of CRISPR.* Cell, 164(1-2), 18-28. doi:10.1016/j.cell.2015.12.041.
8. Ledford, H. (2016). *The Unsung Heroes of CRISPR*. Nature, 535(7612), 342-344. doi:10.1038/535342a.
9. Jinek, M., Chylinski, K., Fonfara, I., Hauer, M., Doudna, J. A., & Charpentier, E. (2012). *A Programmable Dual-RNA-Guided DNA Endonuclease in Adaptive Bacterial Immunity*. Science, 337(6096), 816-821. doi:10.1126/science.1225829.
10. Hamers-Casterman, C., Atarhouch, T., Muyldermans, S., Robinson, G., Hammers, C., Songa, E. B., Hammers, R. (1993). *Naturally Occurring Antibodies Devoid of Light Chains*. Nature, 363(6428), 446-448. doi:10.1038/363446a0.
11. Sidhu, S. S., & Koide, S. (2007). *Phage Display for Engineering and Analyzing Protein Interaction Interfaces.* Current Opinion in Structural Biology, 17(4), 481-487. doi:10.1016/j.sbi.2007.08.007.
12. Steyaert, J., & Kobilka, B. K. (2011). *Nanobody Stabilization of G Protein-Coupled Receptor Conformational States*. Current Opinion in Structural Biology, 21(4), 567-572. doi:10.1016/j.sbi.2011.06.011.
13. Vincke, C., & Muyldermans, S. (2012). *Introduction to Heavy Chain Antibodies and Derived Nanobodies*. Single Domain Antibodies, 15-26. doi:10.1007/978-1-61779-968-6_2.
14. Verheesen, P., & Laeremans, T. (2012). *Selection by Phage Display of Single Domain Antibodies Specific to Antigens in their Native Conformation*. Single Domain Antibodies, 81-104. doi:10.1007/978-1-61779-968-6_6.
15. Li, J., Xia, L., Su, Y., Liu, H., Xia, X., Lu, Q. Reheman, K. (2012). *Molecular Imprint of Enzyme Active Site by Camel Nanobodies*. Journal of Biological Chemistry J. Biol. Chem., 287(17), 13713-13721. doi:10.1074/jbc.m111.336370.
16. Sohier, J., Laurent, C., Chevigné, A., Pardon, E., Srinivasan, V., Wernery, U. Galleni, M. (2013). *Allosteric Inhibition of VIM Metallo-β-Lactamases by a Camelid Nanobody.* Biochemical Journal, 450(3), 477-486. doi:10.1042/bj20121305.
17. Chakravarty, R., Goel, S., & Cai, W. (2014). *Nanobody: The "Magic Bullet" for Molecular Imaging?* Theranostics, 4(4), 386-398. doi:10.7150/thno.8006.

Critical Analysis of Classical Papers

Credits

2

Course Objectives

The objectives of this course are to familiarize students with classic literature to make them appreciate how ground-breaking discoveries were made without, necessarily, use of high-end technologies.

Student Learning Outcomes

Students should be able to train in the exercise of hypothesis building and methods of addressing the hypothesis with readily available technology.

How does the Course Module work? Students may be divided in groups and each group may be responsible for one classical paper. Each week there may be a 1.5 hour presentation cum discussion for each of the papers. At the end of the semester each student will be asked to write a mini-review (2-3 pages long) on any one classical paper, other than the one he/she presented/discussed.

A list of sixteen classic papers and some suggested reference materials:

Syllabus

Molecular Biology

1. Studies on the chemical nature of the substance inducing transformation of Pneumococcal types: Induction of transformation by a desoxyribonucleic acid fraction isolated from *Pneumococcus* type III.
   Avery OT, Macleod CM, McCarty M.; J Exp Med. 1944 Feb 1;79(2):137-58.
   Note: This paper demonstrates that DNA is the transforming Principle originally described by Fredrick Griffith.
2. Independent functions of viral protein and nucleic acid in growth of bacteriophage
   Hershey AD and Chase M.; J Gen Physiol. 1952 May;36(1):39-56.
   Note: Note: This paper demonstrates that DNA, and not protein, component of phages enter bacterial cells.
3. Molecular structure of nucleic acids; a structure for deoxyribose nucleic acid
   Watson JD and Crick FH; Nature. 1953 Apr 25;171(4356):737-8
   Note: In this one page paper Watson and Crick first described the structure of DNA double helix
   Study help - Watson_Crick_Nature_1953_annotated
4. Transposable mating type genes in *Saccharomyces cerevisiae*
   James Hicks, Jeffrey N. Strathern & Amar J.S. Klar; Nature 282, 478-483,1979
   Note: This paper provided evidence for 'cassette hypothesis' of yeast mating type switches *i.e.* interconversion of mating types in yeast *(S. cerevisiae)* occurs by DNA rearrangement.
5. Messelson & Stahl experiment demonstrating semi-conservative replication of DNA.
   Meselson M and Stahl FW.; Proc Natl Acad Sci U S A. 1958 Jul 15;44(7):671-82
   Note: The experiment demonstrating semi-conservative mode of DNA replication is referred to as "the most beautiful experiment in biology"
6. *In vivo* alteration of telomere sequences and senescence caused by mutated *Tetrahymena* telomerase RNAs
   Guo-Liang Yu, John D. Bradley, Laura D. Attardi & Elizabeth H. Blackburn; Nature 344, 126-132, 1990
   Note: This paper demonstrates that the telomerase contains the template for telomere synthesis

Syllabus

Cell Biology

1. A protein-conducting channel in the endoplasmic reticulum
   Simon SM AND Blobel G.; Cell. 1991 May 3;65(3):371-80
   Note: This paper demonstrates the existence of a protein conducting channel
   Study help - A brief history of Signal Hypothesis

2. Identification of 23 complementation groups required for post-translational events in the yeast secretory pathway
   Novick P, Field C, Schekman R.; Cell. 1980 Aug;21(1):205-15
   Note: In this groundbreaking paper Randy Schekman's group used a mutagenesis screen for fast sedimenting yeast mutants to identify genes involved in cell secretion
3. A yeast mutant defective at an early stage in import of secretory protein precursors into the endoplasmic reticulum
   Deshaies RJ and Schekman R.; J Cell Biol. 1987 Aug;105(2):633-45
   Note: Using another yeast mutation screen Schekman lab identifies Sec61, a component of ER protein Conducting Channel (PCC)
   Suggested reference paper - A biochemical assay for identification of PCC.
4. Reconstitution of the Transport of Protein between Successive Compartments of the Golgi
   Balch WE, Dunphy WG, Braell WA, Rothman JE.; Cell. 1984 Dec;39(2 Pt 1):405-16
   Note: This paper describes setting up of an *in vitro* reconstituted system for transport between golgi stacks which eventually paved the way for identification of most of the molecular players involved in these steps including NSF, SNAP *etc.*
5. A complete immunoglobulin gene is created by somatic recombination
   Brack C, Hirama M, Lenhard-Schuller R, Tonegawa S.; Cell. 1978 Sep;15(1):1-14
   Note: This study demonstrates DNA level molecular details of somatic rearrangement of immunoglobulin gene sequences leading to the generation of functionally competent antibody generating gene following recombination.
6. A novel multigene family may encode odorant receptors: a molecular basis for odor recognition
   Buck L and Axel R; Cell. 1991 Apr 5;65(1):175-87
   Note: This paper suggests that different chemical odorants associate with different cell-specific expression of a transmembrane receptor in *Drosophila* olfactory epithelium where a large family of odorat receptors is expressed.
7. Kinesin walks hand-over-hand
   Yildiz A, Tomishige M, Vale RD, Selvin PR.; Science. 2004 Jan 30;303(5658):676-8
   Note: This paper shows that kinesin motor works as a two-headed dimeric motor walking hand-over-hand rather than like an inchworm on microtubule tract using the energy of ATP hydrolysis.

Syllabus
Developmental Biology/ Genetics

1. Mutations affecting segment number and polarity in *Drosophila*
   Christiane Nusslein-Volhard and Eric Weischaus; Nature 287, 795-801, 1980
   Note: This single mutagenesis screen identified majority of the developmentally important genes not only in flies but in other metazoans as well.
2. Information for the dorsal--ventral pattern of the *Drosophila* embryo is stored as maternal mRNA
   Anderson KV and Nüsslein-Volhard C; Nature. 1984 Sep 20-26;311(5983):223-7
   Note: This landmark paper demonstrated that early dorsal-ventral pattern information is stored as maternal mRNA in flies and devised the method of identifying genes encoding such genes
3. Hedgehog signalling in the mouse requires intraflagellar transport proteins
   Huangfu D, Liu A, Rakeman AS, Murcia NS, Niswander L, Anderson KV.; Nature. 2003 Nov 6;426(6962):83-7
   Note: One of the architects of original fly mutagenesis screens conducted a mouse mutagenes screen which identified a gene Kif3a as a major component of hedgehog signaling pathway. Eventually this discovery revolutionizes our understanding of mechanisms of action of signaling pathways by demonstrating central role of cillia in it.
   Suggested Reference paper - Design and execution of a embryonic lethal mutation screen in mouse.

Bioentrepre-neurship

Credits

2

Course Objectives

Research and business belong together and both are needed. In a rapidly developing life science industry, there is an urgent need for people who combine business knowledge with the understanding of science & technology. Bio-entrepreneurship, an interdisciplinary course, revolves around the central theme of how to manage and develop life science companies and projects. The objectives of this course are to teach students about concepts of entrepreneurship including identifying a winning business opportunity, gathering funding and launching a business, growing and nurturing the organization and harvesting the rewards.

Student Learning Outcomes

Students should be able to gain entrepreneurial skills, understand the various operations involved in venture creation, identify scope for entrepreneurship in biosciences and utilize the schemes promoted through knowledge centres and various agencies. The knowledge pertaining to management should also help students to be able to build up a strong network within the industry.

Unit I

Innovation and entrepreneurship in bio-business

8 lectures

Introduction and scope in Bio-entrepreneurship, Types of bio-industries and competitive dynamics between the sub-industries of the bio-sector (*e.g.* pharmaceuticals *vs.* Industrial biotech), Strategy and operations of bio-sector firms: Factors shaping opportunities for innovation and entrepreneurship in bio-sectors, and the business implications of those opportunities, Alternatives faced by emerging bio-firms and the relevant tools for strategic decision, Entrepreneurship development programs of public and private agencies (MSME, DBT, BIRAC, Make In India), strategic dimensions of patenting & commercialization strategies.

Unit II

Bio markets - business strategy and marketing

8 lectures

Negotiating the road from lab to the market (strategies and processes of negotiation with financiers, government and regulatory authorities), Pricing strategy, Challenges in marketing in bio business (market conditions & segments; developing distribution channels, the nature, analysis and management of customer needs), Basic contract principles, different types of agreement and contract terms typically found in joint venture and development agreements, Dispute resolution skills.

Unit III

Finance and accounting

8 lectures

Business plan preparation including statutory and legal requirements, Business feasibility study, financial management issues of procurement of capital and management of costs, Collaborations & partnership, Information technology.

Unit IV

Technology management

8 lectures

Technology – assessment, development & upgradation, Managing technology transfer, Quality control & transfer of foreign technologies, Knowledge centers and Technology transfer agencies, Understanding of regulatory compliances and procedures (CDSCO, NBA, GCP, GLA, GMP).

Recommended Textbooks and References:

1. Adams, D. J., & Sparrow, J. C. (2008). *Enterprise for Life Scientists: Developing Innovation and Entrepreneurship in the Biosciences*. Bloxham: Scion.
2. Shimasaki, C. D. (2014). *Biotechnology Entrepreneurship: Starting, Managing, and Leading Biotech Companies*. Amsterdam: Elsevier. Academic Press is an imprint of Elsevier.

3. Onetti, A., & Zucchella, A. *Business Modeling for Life Science and Biotech Companies: Creating Value and Competitive Advantage with the Milestone Bridge*. Routledge.
4. Jordan, J. F. (2014). *Innovation, Commercialization, and Start-Ups in Life Sciences*. London: CRC Press.
5. Desai, V. (2009). *The Dynamics of Entrepreneurial Development and Management*. New Delhi: Himalaya Pub. House.

Intellectual Property Rights, Biosafety and Bioethics

Credits

2

Course Objectives

The objectives of this course are:

- To provide basic knowledge on intellectual property rights and their implications in biological research and product development;
- To become familiar with India's IPR Policy;
- To learn biosafety and risk assessment of products derived from biotechnology and regulation of such products;
- To become familiar with ethical issues in biological research. This course will focus on consequences of biomedical research technologies such as cloning of whole organisms, genetic modifications, DNA testing.

Student Learning Outcomes

On completion of this course, students should be able to:

- Understand the rationale for and against IPR and especially patents;
- Understand why India has adopted an IPR Policy and be familiar with broad outline of patent regulations;
- Understand different types of intellectual property rights in general and protection of products derived from biotechnology research and issues related to application and obtaining patents;
- Gain knowledge of biosafety and risk assessment of products derived from recombinant DNA research and environmental release of genetically modified organisms, national and international regulations;
- Understand ethical aspects related to biological, biomedical, health care and biotechnology research.

Unit I

Introduction to IPR

5 lectures

Introduction to intellectual property; types of IP: patents, trademarks, copyright & related rights, industrial design, traditional knowledge, geographical indications, protection of new GMOs; International framework for the protection of IP; IP as a factor in R&D; IPs of relevance to biotechnology and few case studies; introduction to history of GATT, WTO, WIPO and TRIPS; plant variety protection and farmers rights act; concept of 'prior art': invention in context of "prior art"; patent databases - country-wise patent searches (USPTO, EPO, India); analysis and report formation.

Unit II

Patenting

5 lectures

Basics of patents: types of patents; Indian Patent Act 1970; recent amendments; WIPO Treaties; Budapest Treaty; Patent Cooperation Treaty (PCT) and implications; procedure for filing a PCT application; role of a Country Patent Office; filing of a patent application; precautions before patenting-disclosure/non-disclosure - patent application- forms and guidelines including those of National Bio-diversity Authority (NBA) and other regulatory bodies, fee structure, time frames; types of patent applications: provisional and complete specifications; PCT and conventional patent applications; international patenting-requirement, procedures and costs; financial assistance for patenting-introduction to existing schemes; publication of patents-gazette of India, status in Europe and US; patent infringement- meaning, scope, litigation, case studies and examples; commercialization of patented innovations; licensing – outright sale, licensing, royalty; patenting by research students and scientists-university/organizational rules in India and abroad, collaborative research - backward and forward IP; benefit/credit sharing among parties/community, commercial (financial) and non-commercial incentives.

Fundamentals of Computational Electromagnetics

COURSE CODE:

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

Computational techniques are used for practical applications in electromagnetic fields, devices, scattering, propagation, and radiation. Techniques like method of moments, finite difference method, finite element method, physical optics, and hybrid methods form the background of various electromagnetic solvers.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Student will be able to identify the best numerical method to simulate a given device.	Familiarity
CO-2	Students will be able to solve scattering problems and antenna radiation/impedance calculation problems	Usage
CO-3	The student will be able to formulate and implement the finite-difference method.	Usage
CO-4	The student will be able to formulate and implement finite volume method.	Assessment

Course Contents:

Unit	Contents	Lectures required
1.	Introduction: Introduction to transmission lines, uniform plane waves, plane waves at Media interface, Microwave waveguide: Rectangular waveguide and circular waveguide.	9
2.	FDM - Finite Difference Method: Background, Finite differencing, Accuracy, Dispersion, Stability, Maxwell PDE System, Maxwell FDTD System, Maxwell FDFD System, Boundary conditions: Introduction Absorbing Boundary Conditions (ABCs).	9
3.	Variational Method: Background, Calculus of Variations, variational methods: Rayleigh-Ritz Method, Method of weighted residuals, Galerkin Method	6
4.	FEM-Finite Element Method: Background, FEM from Weighted Residuals, Formulation (Basis Function, Mapping), Poisson Equation, Time Domain FEM (FETD)	7
5.	MOM- Method of Moments: Galerkin Method Integral Equation, Lorenz Gauge Integral Equation to Matrix Form, Wave equation using potentials, Green Function, Thin Wire Approximation, Magnetic Vector Potential, Incident and radiated field, Pulse basis function.	7

6.	FVM- Finite Volume Method: Motivation and Background Derivation of Eigen value Equation, Discretization Maxwell Equation, Flux function.	4
Total lectures		42

Suggested Text Book(s):

1. A. Bondeson, T. Rylander, and P. Ingelstom, "Computational Electromagnetics", Springers, 2005
2. A. C. Ballanis, "Antenna theory analysis and design", John Willey and Son's Inc., New York, 2005

Suggested Reference Book(s):

1. R. E. Colin. "Foundations for Microwave Engineering" McGraw Hill, 2nd Edition, 2001
2. E. C. Jordan and K. G. Balmain, "Electromagnetic Waves and Radiating Systems" Prentice Hall. Englewood Cliffs, New Jersey, 1998
3. S. Y. Liao, " Microwave solid-state devices", Prentice Hall, 1985
4. D. M. Pozar, "Microwave engineering", John Wiley & Sons, 2009

Other useful resource(s):

1. NPTEL online course: https://nptel.ac.in/courses/108/101/108101090

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered up to T-1
2	T-2	25	1.5 Hours	Syllabus covered up to T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

CO/PO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO1	2	1	3	3	3	2	1	1	1	1	1	1	1.67
CO2	3	3	3	2	2	2	1	1	3	3	2	3	2.33
CO3	3	3	3	3	2	2	1	1	3	2	2	3	2.33
CO4	3	3	3	3	2	2	1	1	3	2	2	2	2.25
Average	2.75	2.50	3.00	2.75	2.25	2.00	1.00	1.00	2.50	2.00	1.75	2.25	

Fundamentals of Digital Image Processing and Applications

COURSE CODE: 20B1WEC533

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

: 3-0-0

Pre-requisite:

Course Objectives:

1. **Describe and explain basic principles of digital imageprocessing.**
2. Design and implement algorithms that perform basic image processing.
3. Design and implement algorithms for advanced image analysis.
4. Assess the performance of image processing algorithms andsystems.

Course Outcomes

This course provides the knowledge of analog and digital communication system analysis and design. After study through lectures and assignments, students will be able to

S. No.	Course Outcomes	Level of Attainment
CO-1	Analyze general terminology of digital image processing.	Familiarity
CO-2	Examine various types of images, intensity transformations and spatial filtering.	Usage
CO-3	Evaluate the methodologies for image segmentation, restoration etc.	Usage
CO-4	Understand different types of medical imaging modalities and would be able to differentiate them with respect to their advantages and limitations.	Usage

Course Contents:

Unit	Contents	Lectures required
1	Digital Image Fundamentals: Fundamental steps in DIP, Components of digital image processing, elements of visual perception, Structure of the human eye, Image formation in the eye, Brightness adaptation and discrimination, light, Image sensing and acquisition, image formation model, definition and some properties of two dimensional system, Discrete 2D convolution, 2D discrete Fourier transform and its properties, optical and modulation transfer function, Spectral density function. Sampling and quantization of images, Two dimensional sampling theory, representation of digital image, Spatial and gray level resolution, zooming and shrinking, some basic relationships between pixels.	7

2	Image Enhancement in the Spatial Domain: Gray Level Transformations, Piecewise linear transformation, Histogram Processing, Enhancement Using Arithmetic/Logic Operations. Basics of Spatial Filtering, Smoothing and Sharpening Spatial Filters, Use of first order and second order derivative in enhancement.	7
3	Image Enhancement in the Frequency Domain: Two dimensional Fourier Transform, properties of frequency domain, correspondence between filtering in spatial and frequency domain, Smoothing and Sharpening frequency domain filters, Homomorphic Filtering.	7
4	Image Restoration: Model of the Image Degradation/Restoration Process, Noise Models, Noise reduction in spatial domain and frequency domain, Inverse filtering, Wiener filtering.	7
5	Image Segmentation: Detection of Discontinuities (point, line edge), Edge Linking and Boundary Detection, Thresholding, Basic global Thresholding, Adaptive Thresholding, Region-Based Segmentation, region growing, splitting and merging.	7
6	Application of Image Processing In Medical Field: Working principle, applications and limitations of different medical imaging modalities. Types of texture parameters: Statistical analysis of texture (First order statistics and Second order statistics), Grey level co-occurrence matrix, grey-level run length matrix.	7
Total lectures		42

Text Books

1. R.C.Gonzalas and R.E.Woods, Digital Image Processing, Prentice Hall, 3rd Ed.
2. Rangaraj M. Rangayyan: Biomedical Image Analysis, 1st Ed., CRC Press, New York , 2004.

Reference Books

1. A.K.Jain, Fundamentals of Digital Image Processing, PrenticeHall.
2. S.Sridhar, Digital Image Processing, Oxford UniversityPress.

EvaluationScheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus

4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes(2) -10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Fundamentals of Digital Image Processing & Applications)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	3	3	3	3	2	3	1	2	1	2	2.42
CO-2	3	3	3	3	2	0	0	1	2	3	1	1	1.83
CO-3	3	3	3	3	3	1	1	1	1	2	1	1	1.92
CO-4	3	3	3	3	3	3	2	3	2	2	3	3	2.75
Average	3.00	3.00	3.00	3.00	2.75	1.75	1.25	2.00	1.50	2.25	1.50	1.75	

Forensic Image Processing

COURSE CODE:

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Prerequisite: Fundamentals of Digital Image Processing

Course Objectives:

1. To aware the students about the role of image processing for forensic investigations.
2. To introduce different attributes of the image source that helps in the identification of the source of the image.
3. To make students understand the role of watermarking, cryptography and other methods used for forensic investigation.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Understand the requirement of image processing in Image processing	Familiarity
CO-2	Understand the working of digital image capturing devices and parameters related to the devices.	Usage
CO-3	Understand the attributes of the image source for forensic investigation.	Usage
CO-4	Able to implement watermarking and cryptography methods on images.	Assessment
CO-5	Able to compare the two images and identify the content present in them.	Assessment

Course Contents:

Unit	Contents	Lectures required
1	Forensic image analysis: A Framework and its applications (Example of Police cases solved with forensic image processing)	3
2	Digital Still and Video Cameras: Dynamic Range, Light and Lenses, Setting exposure, Resolution, File format and compressions, JPEG and MPEG compression	7
3	Image Enhancement and Restoration: Color Spaces, Color Correction, Interpol tion, Convolutions, Enhancement Filters, Morphological Filters, Sharpening Contrast	8
4	Techniques attributing an image to its source: Image and Video source class identification, Sensor defects in digital image forensic	8
5	Detecting doctored images: Digital Watermarking and cryptography	8

6	Photo Image Comparison, Image Content Analysis, Image Authentication	8
Total lectures		42

Suggested Text Book(s):

1. Sencar, Husrev Taha, Memon, Nasir (Eds.), "Digital Image Forensics: There is More to a Picture than Meets the Eye", Springer, 2012.

Suggested Reference Book(s):

1. Anthony T. S. Ho, Shujun Li, "Handbook of Digital Forensics of Multimedia Data and Devices", Wiley 2016.
2. Ahmed Bouridane, "Imaging for Forensics and Security", Springer, 2009

Other useful resource(s):

1. Judith A. Redi, Wiem Taktak & Jean-Luc Dugelay, "Digital image forensics: a booklet for beginners", Multimedia Tools and Applications volume 51, pages133–162, 2011.
2. NPTEL online course: https://www.youtube.com/watch?v=O2RwWHWHQlM

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered up to T-1
2	T-2	25	1.5 Hours	Syllabus covered up to T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Average
CO1	2	3	2	2	2	2	2	x	x	2	2	2	2.1
CO2	2	3	2	2	2	2	2	x	x	2	2	2	2.1
CO3	3	3	3	3	3	2	2	x	3	2	2	2	2.54
CO4	3	3	3	3	3	2	2	x	3	2	2	2	2.54
CO5	3	3	3	3	3	2	2	x	3	2	2	2	2.54
Average	2.6	3	2.6	2.6	2.6	2	2	x	3	2	2	2	

FPGA based Instrumentation System Design

COURSE CODE: 18B1WEC744

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Digital Electronics, Basic Electronics

Course Objectives:

1. Learn and understand the FPGA design flow
2. Learn to implement basic arithmetic circuits and DSP algorithms in FPGA using IP cores.
3. Learn to determine circuit speed, to check timing violations and techniques to fix them.
4. Learn to apply the knowledge gained to break an algorithm into arithmetic functions and implement in FPGA with/without using IP cores.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Explain the concept and basic structures of Field Programmable Gate Array (FPGA), and techniques to implement programmable logic circuits using typical FPGA design flow	Familiarity
CO-2	Implementing basic arithmetic circuits and ASICs for simple DSP functions, such as filters using user defined or vendor provided IP cores	Assessment
CO-3	Determining circuit speed, checking timing violations and techniques to fix the timing violations.	Usage
CO-4	Design issues in cross clock domains communication in high-speed ASIC design	Assessment
CO-5	Break any given algorithm to sub-modules and implement the same on FPGA using HDLs and various IP cores	Usage

Course Contents:

Unit	Contents	Lectures required
1	Introduction to FPGA : From discrete logic to FPGAs, flexibility and functionality, FPGA vs Programmable DSPs, FPGA technology - roadmap, clocking, data and sample rates, slices and configurable logic blocks, memory and registers, performance ratings, families DSP and FPGAs: FPGA elements for DSP algorithms, FPGA- Based System Design Examples	6
2	Verilog HDL: Data types, operators, Multiplexers, decoders, adders, Subtractor, de-multiplexers, flip-flops, counters, state machine, ALU with adder/Subtractor and shifter, multiply and divide hardware synthesis, memory, using a test bench for verification and simulation Concept of state machine and VHDL implementation, simulation synthesis, verification, : FSM Types, Implementation in HDLs, a simple computer design, other Design examples and case studies	12
3	Digital System Design: Combinational and sequential circuits, Classification of sequential circuits, Registers. Design & analysis of synchronous and asynchronous sequential circuits: Counters.	6
4	Embedded Systems & FPGAs: FPGA as a systems on chip platform, FPGA on-chip network standards, FPGAs as custom microcontroller and hybrid DSP microcontroller devices, Multiple cock domains on chip, Multi FPGA systems, multiple-clock domains, program and data memory, SRAM and DRAM., ROM, PAL, and PLA, Timing Constraints, using IP cores: instantiation and simulations	6
5	Instrumentation System: Basic concepts, Weighted Resistor D/A converter, A/D Converter, programmable ICs, digital potentiometers, various data communication and interfacing protocols (UART, SPI, I2C and others) and FPGA implementation case studies	12
Total lectures		42

Suggested Text Book(s):

1. Michael D. Ciletti: Advanced Digital Design with the Verilog HDL, 2nd Edition, Pearson, 2011.
2. Jean- Pierre Deschamps, Gustavo D. Sutter, Enique Cano: Guide to FPGA Implementation of Arithmetic Functions, Springer, 2012.

Suggested Reference Book(s):

1. Hamblen, J.O, Hall, T.S, and Furman, M.D., "Rapid Prototyping of Digital Systems, SOPC Edition." Springer, 2008.
2. Zainalabedin, Navabi, "Digital Design and Implementation with Field Programmable Devices", Springer, 2005.
3. Jean- Pierre Deschamps, Gery Jean Antoine Bioul, Gustavo D. Sutter, "Synthesis of Arithmetic Circuits-FPGA ASIC and Embedded Systems" , a John Wiley & sons, inc, publication, 2006.

Other useful resource(s):

1. FPGA manufacturer's web resources:
   Altera Inc.: https://www.altera.com/products/general/fpga/stratix-fpgas/about/stx-asic-prototyping.html
   Xilinx: https://www.xilinx.com/applications/asic-prototyping.html
2. Other Journal/research resources:
   http://biomedical-engineering-online.biomedcentral.com/articles/10.1186/1475-925X-13-126
   http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.470.6049&rep=rep1&type=pdf
3. NPTEL Resources
   https://nptel.ac.in/courses/117108040/
   https://nptel.ac.in/courses/117106092/55
   https://nptel.ac.in/syllabus/117108040/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (FPGA based Instrumentation System Design)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	2	3	1	2	2	x	1	3	3	1	2	1.67
CO-2	3	2	3	1	2	2	x	x	3	1	1	2	1.67
CO-3	3	3	3	2	3	2	x	x	3	2	1	2	2.00
CO-4	3	3	3	2	3	2	x	x	3	2	1	2	2.00
CO-5	3	3	3	3	3	2	x	x	3	2	1	2	2.08
Average	3	2.6	3	1.8	2.6	2	0	0	3	1.6	1	2	

Genomics and Proteomics

Credits

2

Course Objectives

The objectives of this course is to provide introductory knowledge concerning genomics, proteomics and their applications.

Student Learning Outcomes

Students should be able to acquire knowledge and understanding of fundamentals of genomics and proteomics, transcriptomics and metabolomics and their applications in various applied areas of biology.

Unit I

Basics of genomics and proteomics

3 lectures

Brief overview of prokaryotic and eukaryotic genome organization; extra-chromosomal DNA: bacterial plasmids, mitochondria and chloroplast.

Unit II

Genome mapping

4 lectures

Genetic and physical maps; markers for genetic mapping; methods and techniques used for gene mapping, physical mapping, linkage analysis, cytogenetic techniques, FISH technique in gene mapping, somatic cell hybridization, radiation hybrid maps, *in situ* hybridization, comparative gene mapping.

Unit III

Genome sequencing projects

3 lectures

Human Genome Project, genome sequencing projects for microbes, plants and animals, accessing and retrieving genome project information from the web.

Unit IV

Comparative genomics

5 lectures

Identification and classification of organisms using molecular markers- 16S rRNA typing/sequencing, SNPs; use of genomes to understand evolution of eukaryotes, track emerging diseases and design new drugs; determining gene location in genome sequence.

Unit V

Proteomics

5 lectures

Aims, strategies and challenges in proteomics; proteomics technologies: 2D-PAGE, isoelectric focusing, mass spectrometry, MALDI-TOF, yeast 2-hybrid system, proteome databases.

Unit VI

Functional genomics and proteomics

8 lectures

Transcriptome analysis for identification and functional annotation of gene, Contig assembly, chromosome walking and characterization of chromosomes, mining functional genes in genome, gene function- forward and reverse genetics, gene ethics; protein-protein and protein-DNA interactions; protein chips and functional proteomics; clinical and biomedical applications of proteomics; introduction to metabolomics, lipidomics, metagenomics and systems biology.

Recommended Textbooks and References:

1. Primrose, S. B., Twyman, R. M., Primrose, S. B., & Primrose, S. B. (2006). *Principles of Gene Manipulation and Genomics*. Malden, MA: Blackwell Pub.
2. Liebler, D. C. (2002). *Introduction to Proteomics: Tools for the New Biology.* Totowa, NJ: Humana Press.
3. Campbell, A. M., & Heyer, L. J. (2003). *Discovering Genomics, Proteomics, and Bioinformatics*. San Francisco: Benjamin Cummings.

Molecular Diagnostics

Credits

2

Course Objectives

The objectives of this course are to sensitize students about recent advances in molecular biology and various facets of molecular medicine which has potential to profoundly alter many aspects of modern medicine including pre- or post-natal analysis of genetic diseases and identification of individuals predisposed to disease ranging from common cold to cancer.

Student Learning Outcomes

Students should be able to understand various facets of molecular procedures and basics of genomics, proteomics and metabolomics that could be employed in early diagnosis and prognosis of human diseases.

Unit I

Genome biology in health and disease

4 lectures

DNA, RNA, Protein: An overview; chromosomal structure & mutations; DNA polymorphism: human identity; clinical variability and genetically determined adverse reactions to drugs.

Unit II

Genome: resolution, detection & analysis

5 lectures

PCR: Real-time; ARMS; Multiplex; ISH; FISH; ISA; RFLP; DHPLC; DGGE; CSCE; SSCP; Nucleic acid sequencing: new generations of automated sequencers; Microarray chips; EST; SAGE; microarray data normalization & analysis; molecular markers: 16S rRNA typing; Diagnostic proteomics: SELDI-TOF-MS; Bioinformatics data acquisition & analysis.

Unit III

Diagnostic metabolomics

2 lectures

Metabolite profile for biomarker detection the body fluids/tissues in various metabolic disorders by making using LCMS & NMR technological platforms.

Unit IV

Detection and identity of microbial diseases

4 lectures

Direct detection and identification of pathogenic-organisms that are slow growing or currently lacking a system of *in vitro* cultivation as well as genotypic markers of microbial resistance to specific antibiotics.

Unit V

Detection of inherited diseases

4 lectures

Exemplified by two inherited diseases for which molecular diagnosis has provided a dramatic improvement of quality of medical care: Fragile X Syndrome: Paradigm of new mutational mechanism of unstable triplet repeats, von-Hippel Lindau disease: recent acquisition in growing number of familial cancersyndromes.

Unit VI

Molecular oncology

5 lectures

Detection of recognized genetic aberrations in clinical samples from cancer patients; types of cancer-causing alterations revealed by next-generation sequencing of clinical isolates; predictive biomarkers for personalized onco-therapy of human diseases such as chronic myeloid leukemia, colon, breast, lung cancer and melanoma as well as matching targeted therapies with patients and preventing toxicity of standard systemic therapies.

Unit VII

Quality assurance and control

1 lecture

Quality oversight; regulations and approved testing.

Recommended Textbooks and References:

1. Campbell, A. M., & Heyer, L. J. (2006). *Discovering Genomics, Proteomics, and Bioinformatics*. San Francisco: BenjaminCummings.
2. Brooker, R. J. (2009). *Genetics: Analysis & Principles*. New York, NY: McGraw-Hill.

3. Glick, B. R., Pasternak, J. J., & Patten, C. L. (2010). *Molecular Biotechnology: Principles and Applications of Recombinant DNA*. Washington, DC: ASM Press.
4. Coleman, W. B., & Tsongalis, G. J. (2010). *Molecular Diagnostics: for the Clinical Laboratorian*. Totowa, NJ: Humana Press.

Research Methodology and Scientific Communication Skills

Credits

2

Course Objectives

The objectives of this course are to give background on history of science, emphasizing methodologies used to do research, use framework of these methodologies for understanding effective lab practices and scientific communication and appreciate scientific ethics.

Student Learning Outcomes

Students should be able to:

- Understand history and methodologies of scientific research, applying these to recent published papers;
- Understand and practice scientific reading, writing and presentations;
- Appreciate scientific ethics through case studies.

Unit I
History of science and science methodologies
8 lectures

Empirical science; scientific method; manipulative experiments and controls; deductive and inductive reasoning; descriptive science; reductionist *vs* holistic biology.

Unit II
Preparation for research
2 lectures

Choosing a mentor, lab and research question; maintaining a lab notebook.

Unit III
Process of communication
5 lectures

Concept of effective communication- setting clear goals for communication; determining outcomes and results; initiating communication; avoiding breakdowns while communicating; creating value in conversation; barriers to effective communication; non-verbal communication-interpreting non-verbal cues; importance of body language, power of effective listening; recognizing cultural differences; Presentation skills - formal presentation skills; preparing and presenting using over-head projector, PowerPoint; defending interrogation; scientific poster preparation & presentation; participating in group discussions; Computing skills for scientific research - web browsing for information search; search engines and their mechanism of searching; hidden Web and its importance in scientific research; internet as a medium of interaction between scientists; effective email strategy using the right tone and conciseness.

Unit IV
Scientific communication
9 lectures

Technical writing skills - types of reports; layout of a formal report; scientific writing skills - importance of communicating science; problems while writing a scientific document; plagiarism, software for plagiarism; scientific publication writing: elements of a scientific paper including abstract, introduction, materials & methods, results, discussion, references; drafting titles and framing abstracts; publishing scientific papers - peer review process and problems, recent developments such as open access and non-blind review; plagiarism; characteristics of effective technical communication; scientific presentations; ethical issues; scientific misconduct.

Introduction to Machine Learning

COURSE CODE:

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite:

None

Course Objectives:

1. To introduce students to the basic concepts and techniques of Machine Learning.
2. To become familiar with regression methods, and classification methods.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Gain knowledge about basic concepts of Machine Learning	Familiarity
CO-2	Understand complexity of Machine Learning algorithms and their limitations	Familiarity
CO-3	Solve the problems using various machine learning techniques	Usage
CO-4	Design application using machine learning techniques	Assessment
CO-5	Capable of performing experiments in Machine Learning using real-world data.	Assessment

Course Contents:

Unit	Contents	Lectures required
1	Introduction: Overview of intelligent systems and machine learning, Supervised learning, Unsupervised learning, Reinforcement learning, Bias-variance trade-off, Overfitting, Underfitting, Goals and applications of machine learning	5
2	Linear Regression with One Variable: Model representation, Cost function, Gradient descent, Gradient descent for linear regression	4
3	Linear Algebra: Matrices and vectors, Addition and scalar multiplication, Matrix vector multiplication, Matrix multiplication, Matrix multiplication properties, Inverse and transpose, Multivariable calculus, and Modern applications	3

4	Linear Regression with Multiple Variables: Multiple features, Gradient descent for multiple variables, Feature scaling, Learning rate, Features and polynomial Regression, Normal equation, Noninvertibility	6

5	Logistic Regression: Classification, Hypothesis representation, Decision boundary, Cost function, Simplified cost function and Gradient descent, Advanced optimization, Multiclass classification: One-vs-all	6
6	Bayesian Learning: Probability theory and Bayes rule, Naive Bayes learning algorithm, Parameter smoothing, Generative vs. discriminative training, Bayes nets and Markov nets for representing dependencies.	6
7	Regularization: The Problem of overfitting, Cost function, Regularized linear regression, Regularized logistic regression	4
8	K-Nearest Neighbours: Introduction, KNN algorithm, Parameter selection , KNN as Classifier, KNN as Regressor, Applications	4
9	Machine Learning System Design: Error analysis, Error metrics for skewed classes, Trading off precision and recall, Data for Machine Learning	4
Total lectures		42

Suggested Text Book(s):

1. C. Bishop: Pattern Recognition and Machine learning, Springer, 2006.
2. H. Daume: A course in Machine leaning, 2015.
3. Ethem Alpaydin, “Introduction to Machine Learning”, Second Edition, The MIT Press, Cambridge, 2010.

uggested Reference Book(s):

1 T. Hastie, R. Tibshirani, J. Friedman: The Elements of Statistical Learning: Data Mining, Inference, and Prediction, Springer, 2013.

2. Stephen Marsland, “Machine Learning: An Algorithmic Perspective”, Second Edition, Chapman and Hall/CRC, 2014.

Other useful resource(s):

1. Link to NPTEL course contents: Introduction to Machine Learning https://onlinecourses.nptel.ac.in/noc17_cs26/preview
2. Link to MITOPENCOURESEWARE: Machine Learning https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-867-machine-learning-fall-2006/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered up to T-1
2	T-2	25	1.5 Hours	Syllabus covered up to T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

CO/PO (Introduction to Machine Learning)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO1	3	3	2	2	2	2	2	1	1	2	3	3	2.17
CO2	3	3	3	2	3	2	2	1	1	2	3	3	2.33
CO3	3	3	3	3	3	3	3	1	3	3	3	3	2.83
CO4	3	3	3	3	3	3	3	1	3	3	3	3	2.83
CO5	3	3	3	3	3	3	3	1	3	3	3	3	2.83
Average	3.00	3.00	2.80	2.60	2.80	2.60	2.60	1.00	2.20	2.60	3.00	3.00	

PhD Course

Low Power CMOS VLSI Circuit Design

COURSE CODE: 20P11EC112

COURSE CREDITS: 3

CORE/ELECTIVE: PhD

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

1. Students shall understand the fundamentals of power dissipation due to various reasons
2. Students shall be able to design and test low voltage, low power CMOS circuits specifically low power SRAM cells.
3. Students shall learn to use energy recovery techniques and understand the impact of algorithmic techniques on overall power optimization in CMOS circuits

Course Outcomes :

S.No.	Course Outcomes	Level of Attainment
CO-1	Understand the fundamentals of power dissipation in microelectronic devices.	Familiarity
CO-2	Understand and estimate power dissipation due to switching, short circuit, sub threshold leakage and diode leakage current.	Familiarity
CO-3	To be able to design and test low-voltage CMOS circuits	Assessment
CO-4	Understand power-conscious logic and high-level synthesis of circuits.	Assessment
CO-5	Understand low-power static RAM architecture.	Usage
CO-6	To be able to perform low-energy computing using energy recovery techniques.	Usage
CO-7	Understand software power estimation and optimization	

Course Contents :

S. No.	Contents	Lecture Required
1.	Introduction: Physics and source of power dissipation in CMOS FET devices,Need	2

	for low power VLSI chips, Emerging low power approaches.	
2.	Device and Technology Impact on Power Estimation: Dynamic dissipation in CMOS, Effect of and on speed, Constraint on reduction, Transistor sizing and gate oxide thickness, Impact of technology scaling.	7
3.	Low power circuit techniques: Power consumption in circuits, High capacitance nodes, Capacitive power estimation, Switching activity reduction.	2
4.	Synthesis for Low Power: Power estimation techniques, Power minimization techniques, Logic synthesis, Verification, High level synthesis. General purpose methods for power optimization-Partitioning, Floor planning and pin assignment, Routing.	8
5.	Design and Test of Low-Voltage CMOS circuits:Deep sub-micron low voltage CMOS circuit, Multiple VT and dynamic VT, Circuit techniques-MTCMOS, VTCMOS, DTMOS, SCMOS, SOI implementation.	8
6.	Low-Power Static Ram Architectures and Clock Distribution:Power dissipation in SRAM architecture,Power dissipation in clock distribution, Low power SRAM circuits, Zero skew and tolerable skew, Single driver vs Distributed buffers, Power reduction in clock networks.	9
7.	Low-Energy Computing Using Energy Recovery Techniques: Basic energy recovery computing system, Retractile logic, Reversible pipelines, High-performance approaches.	4
8.	Software Design for Low Power: Software power optimization techniques, Power dissipation influenced by software.	2
	Total	42

Suggested Text Book(s) :

1. Jan M. Rabaey and Massoud Pedram, Low Power Design Methodologies, springer, 2009.
2. Kaushik Roy and Sharat C. Prasad, Low-Power CMOS VLSI Circuit Design, Wiley-Interscience, 1st Ed, 2009.

Suggested Reference Book(s):

1. Wolfgang Nebel, Jean P. Mermet, Low Power Design in Deep Sub-micron Electronics, springer, 1st Ed.
2. David A. Hodges, Horace G. Jackson, Analysis and Design of Digital Integrated Circuits in Deep Sub-micron Technology, McGraw Hill, 3rd Ed.

Medical Image Processing

COURSE CODE: 18B1WEC847

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

1. To introduce various medical imaging modalities.
2. To teach the requirement and development of different blocks of computer aided diagnosis for medical images.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Able to understand different types of medical imaging modalities and would be able to differentiate them with respect to their advantages and limitations.	Familiarity
CO-2	Acquire an ability to analyze and process medical images.	Usage
CO-3	Understand different feature extraction techniques and classifiers used for image classification.	Usage
CO-4	Understand the role of computer aided diagnosis for medical images.	Assessment

Course Contents:

Unit	Contents	Lectures required
1	Introduction to Image Processing:- Acquisition of Images, Image Sampling and quantization; Spatial and histogram based enhancement; Noise modeling, Image restoration. Image transformation.	8
2	Edge Detection and Image Segmentation: Gradient based edge detectors. Intensity thresholding based image segmentation; Region growing and region splitting algorithm; watershed segmentation.	8
3	Medical Imaging Modalities: Working principle, applications and limitations of Computed tomography , X-ray, Magnetic resonance imaging, Ultrasound imaging, and Positron emission tomography; Various Artifacts.	6
4	Image Texture: Types of texture parameters: Statistical analysis of texture (First order statistics and Second order statistics), Grey level co-occurrence matrix, grey-level run length matrix.	8
5	Pattern classification: Supervised and Unsupervised pattern classification, Neural Network classifier, Support Vector Machines.	6
6	Case Studies: Pre-processing, Segmentation, Feature extraction, and Classification of medical images.	6
Total lectures		42

Suggested Text Book(s):

1. Chris Solomon, Toby Breckon: Fundamental of Digital Image Processing, 1st Ed., John Wiley & Sons, 2011.
2. Rangaraj M. Rangayyan: Biomedical Image Analysis, 1st Ed., CRC Press, New York , 2004.

Suggested Reference Book(s):

1. RC Gonzalez, RE Woods, Digital Image Processing, 3rd Ed., Pearson Publisher, 2008.
2. Kayvan Najarian, Robert Splinter: Biomedical Signal and Image Processing, 2nd Ed., CRC Press, 2012

3. Tamal Bose: Digital Signal and Image Processing, 1st Ed., John Wiley & Sons, 2003.

Other useful resource(s):

http://www.nptelvideos.in/2012/12/digital-image-processing.html (Prof P.K. Biswas, IIT Kharagpur)

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes(2) -10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Medical Image Processing)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	3	3	3	3	2	3	1	2	1	2	2.42
CO-2	3	3	3	3	2	0	0	1	2	3	1	1	1.83
CO-3	3	3	3	3	3	1	1	1	1	2	1	1	1.92
CO-4	3	3	3	3	3	3	2	3	2	2	3	3	2.75
Average	3.00	3.00	3.00	3.00	2.75	1.75	1.25	2.00	1.50	2.25	1.50	1.75	

Machine Learning for Data Analysis

COURSE CODE:

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Introduction to Machine Learning

(20B1WEC531) Course Objectives:

1. To provide a broad survey of approaches and techniques in machine learning;
2. To develop the design and programming skills that will help you to build intelligent, adaptive artifacts.
3. To develop the basic skills necessary to pursue research in machine learning.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Understand the basic theory underlying machine learning.	Familiarity
CO-2	Understand a range of machine learning algorithms along with their strengths and weaknesses.	Usage
CO-3	Apply machine learning algorithms to solve problems of moderate complexity.	Assessment
CO-4	Formulate machine learning problems corresponding to different applications.	Assessment
CO-5	Read current research papers and understand the issues raised by current research.	Usage

Unit	Contents	Lectures required
1	Introduction: Definition of learning systems, Goals and applications of machine learning, Aspects of developing a learning system: training data, concept representation, function approximation.	3
2	Data Exploration and Pre-processing: Data objects and attributes; Statistical measures, Visualization, Data cleaning and integration	4
3	Decision Tree based Learning: Decision tree induction, Attribute selection and tree pruning.	5
4	Support Vector Machines: Maximum margin linear separators, Quadractic programming solution to finding maximum margin separators, Kernels for learning non-linear functions.	5
5	Dimensionality Reduction: Discriminant analysis; Principal component analysis, Independent component analysis; Transform Domain and statistical feature extraction and reduction.	7
6	Clustering and Unsupervised Learning: Learning from unclassified data,	8

	Clustering, Hierarchical Aglomerative Clustering, k-means clustering, Density based clustering.	
7	Artificial Neural Networks: Single layer neural network, Multilayer Perceptron, Back Propagation learning, Functional link artificial neural network, Radial basis function network, Recurrent neural networks, Convolution neural network.	10
Total lectures		42

Suggested Text Book(s):

1. J. Watt, R. Borhani and A. K. Katsaggelos: Machine Learning Refined: Foundations, Algorithms and Applications, Cambridge University Press, 1st ed., 2016.
2. C. Bishop: Pattern Recognition and Machine Learning, Springer, 1st ed., 2006.
3. J. Han, M. Kamber, J. Pei: Data Mining: Concepts and Techniques, Elsevier Amsterdam, 3rd ed., 2011

Suggested Reference Book(s):

1. T. Hastie, R. Tibshirani, J. Friedman: The Elements of Statistical Learning: Data Mining, Inference, and Prediction, Springer, 2013.
2. H. Simon: Neural Networks and Learning Machines, Prentice Hall, 3rd ed., 2009.

Other useful resource(s):

1. H. Daume: A course in Machine Leaning, 2015. http://ciml.info/
2. Link to NPTEL course contents: Introduction to Machine Learning https://onlinecourses.nptel.ac.in/noc17_cs26/preview
3. Link to MITOPENCOURESEWARE: Machine Learning
https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-867-machine-learning-fall-2006/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (3) - 10 Quizzes (3) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Machine Learning and Data Analytics)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	2	2	2	2	2	1	1	2	3	3	2.17
CO-2	3	3	3	2	3	2	2	1	1	2	3	3	2.33
CO-3	3	3	3	3	3	3	3	1	3	3	3	3	2.83
CO-4	3	3	3	3	3	3	3	1	3	3	3	3	2.83
CO-5	3	3	3	3	3	3	3	1	3	3	3	3	2.83
Average	3.00	3.00	2.80	2.60	2.80	2.60	2.60	1.00	2.20	2.60	3.00	3.00	

Microwave Theory and Techniques

COURSE CODE: 18B1WEC746

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Basics of Electromagnetic Engineering

Course Objectives:

1. To learn the basic principles of microwave generators and amplifiers.
2. To have foundations on microwave design principles and measurement.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	To identify different microwave components and their applications.	Familiarity
CO-2	To study the performance of specialized microwave tubes such as klystrons.	Familiarity
CO-3	To understand the principle of operation of magnetrons, traveling wave tubes and BWOs.	Assessment
CO-4	To understand the working principle of microwave solid state devices and their applications.	Assessment
CO-5	To design of microwave filters, amplifiers and oscillators.	Usage
CO-6	To learn about microwave power, VSWR, impedance and attenuation measurements.	Usage

Course Contents:

Unit	Contents	Lectures required
1	Introduction: Introduction to microwaves, Scattering matrix of microwave waveguide junction, properties of S-matrix, E-plane tee, H-plane tee, magic tee, attenuators, directional couplers, ferrite devices, Faraday rotation, gyrator, isolator, circulators and cavity resonators.	8
2	Microwave Tubes: Limitations and losses of conventional tubes at microwave frequencies, microwave tubes-O-type and M-type classifications. O-type tubes: Two cavity klystron-structure, reentrant cavities, velocity modulation process and apple gate diagram, bunching process and small signal theory- expression for output power and efficiency. Reflex Klystron-Structure, velocity modulation and apple gate diagram, mathematical theory of bunching, power output, efficiency, oscillating modes and output characteristics.	9
3	Microwave Crossed-Filed Tubes: M-Type tubes: Introduction, cross filed effects, magnetrons-different types, cylindrical travelling wave magnetron-Hull cut-off and Hartree conditions, mode of resonance and PI-mode of operations, separation of PI-mode, output characteristics, Backward wave crossed field oscillator (Carcinotron).	6
4	Helix TWTs: Significance, types and characteristics of slow wave structures, structure of TWT and amplification process (qualitative treatment), suppression of oscillations, gain considerations.	5
5	Microwave Solid state Devices: Introduction, classification, applications. TEDs-Introduction, Gunn diodes-principle, RWH theory, characteristics, modes of operations, IMPATT diode, TRAPATT Diode, BARITT diode, PIN diode, Tunnel diode.	7
6	Microwave Design Principles and Measurements: Microwave Filter Design, Microwave Amplifier Design, Low Noise Amplifier Design, Microwave Oscillator Design, VSWR and impedance measurement, attenuation measurement and power measurement.	7
Total lectures		42

Suggested Text Book(s):

1. Samuel Y.Liao, " Microwave Devices and Circuits", 3rd Edition, Pearson education, 2003.
2. R.E.Collin, "Foundations for microwave Engineering", 2nd Edition, Tata Mc Graw Hill, 1992.
3. Pozar, David M. "Microwave engineering", 4th Edition, John Wiley & Sons, 2013.

Suggested Reference Book(s):

1. Annapurna Das, Sisir.K.Das, "Microwave Engineering",1st Edition, Tata McGraw Hill, 2000.

Other useful resource(s):

1. Link to topics related to course: https://nptel.ac.in/courses/108101112

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Microwave Theory and Techniques)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	1	2	1	1	2	1	2	2	2	2	1	1.58
CO-2	2	3	3	3	3	1	2	1	1	2	1	1	1.92
CO-3	3	2	2	2	3	1	1	1	2	2	2	1	1.83
CO-4	2	3	3	3	2	1	2	1	1	3	1	2	2.0
CO-5	3	3	3	3	2	1	1	1	2	3	2	1	2.08
CO-6	3	3	2	2	3	1	1	1	1	2	1	2	1.83
Average	2.5	2.5	2.5	2.33	2.33	1.16	1.33	1.16	1.5	2.33	1.5	1.33	

Recommended Textbooks and References:

1. Lee, Y.K. (2013). *Microbial Biotechnology: Principles and Applications*. Hackensack, NJ: World Scientific.
2. Moo-Young, M. (2011). *Comprehensive Biotechnology*. Amsterdam: Elsevier.
3. Nelson, K. E. (2015). Encyclopedia of Metagenomics. *Genes, Genomes and Metagenomes: Basics, Methods, Databases and Tools*. Boston, MA: Springer US.
4. *The New Science of Metagenomics Revealing the Secrets of Our Microbial Planet*. (2007). Washington, D.C.: National Academies Press.
5. Journals: (a) Nature, (b) Nature Biotechnology, (c) Applied microbiology and biotechnology, (d) Trends in Biotechnology, (e) Trends in Microbiology, (f) Current opinion in Microbiology, (g) Biotechnology Advances, (h) Genome Research)
6. Websites: http://jgi.doe.gov/our-science/

Protein Engineering

Credits

2

Course Objectives

The aim of this course is to introduce methods and strategies commonly used in protein engineering.

Student Learning Outcomes

On completion of this course, students should be able to:

- Analyse structure and construction of proteins by computer-based methods;
- Describe structure and classification of proteins;
- Analyse purity and stability of proteins and explain how to store them in best way;
- Explain how proteins can be used for different industrial and academic purposes such as structure determination, organic synthesis and drug design.

Unit I

Introduction to protein engineering

5 lectures

Protein engineering – definition, applications; Features or characteristics of proteins that can be engineered (definition and methods of study) – affinity and specificity; Spectroscopic properties; Stability to changes in parameters as pH, temperature and amino acid sequence, aggregation propensities, *etc.* Protein engineering with unnatural amino acids and its applications.

Unit II

Stability of protein structure

5 lectures

Methods of measuring stability of a protein; Spectroscopic methods to study physicochemical properties of proteins: far-UV and near-UV CD; Fluorescence; UV absorbance; ORD; Hydrodynamic properties–viscosity, hydrogen-deuterium exchange; Brief introduction to NMR spectroscopy – emphasis on parameters that can be measured/obtained from NMR and their interpretation.

Unit III

Applications

5 lectures

Forces stabilizing proteins – Van der waals, electrostatic, hydrogen bonding and weakly polar interactions, hydrophobic effects; Entropy – enthalpy compensation; Experimental methods of protein engineering: directed evolution like gene site saturation mutagenesis; Module shuffling; Guided protein recombination, *etc.*, Optimization and high throughput screening methodologies like GigaMetrix, High throughput microplate screens *etc.*, Application to devices with bacteriorhodopsin as an example; Engineering antibody affinity by yeast surface display; Applications to vaccines, Peptidomimetics and its use in drug discovery.

Unit IV

Computational approaches

5 lectures

Computational approaches to protein engineering: sequence and 3D structure analysis, Data mining, Ramachandran map, Mechanism of stabilization of proteins from psychrophiles and thermophiles *vis-à-vis* those from mesophiles; Protein design, Directed evolution for protein engineering and its potential.

Unit V

Case studies

1 lecture

Case Studies.

Recommended Textbooks and References:

1. Edited by T E Creighton, (1997), *Protein Structure: a Practical Approach*, 2nd Edition, Oxford university press.
2. Cleland and Craik, (2006), *Protein Engineering, Principles and Practice*, Vol 7, Springer Netherlands.
3. Mueller and Arndt, *Protein Engineering Protocols*, 1st Edition, Humana Press.
4. Ed. Robertson DE, Noel JP, (2004), *Protein Engineering Methods in Enzymology*, 388, Elsevier Academic Press.
5. J Kyte; (2006), *Structure in Protein Chemistry*, 2nd Edition, Garland publishers.

Nano-biotechnology

Credits

2

Course Objectives

The course aims at providing a general and broad introduction to multi-disciplinary field of nanotechnology. It will familiarize students with the combination of the top-down approach of microelectronics and micromechanics with the bottom-up approach of chemistry/biochemistry; a development that is creating new and exciting cross-disciplinary research fields and technologies. The course will also give an insight into complete systems where nanotechnology can be used to improve our everyday life.

Student Learning Outcomes

On successful completion of this course, students should be able to describe basic science behind the properties of materials at nanometre scale, and the principles behind advanced experimental and computational techniques for studying nanomaterials.

Unit I

Introduction to nanobiotechnology

5 lectures

Introduction to Nanobiotechnology; Concepts, historical perspective; Different formats of nanomaterials and applications with example for specific cases; Cellular Nanostructures; Nanopores; Biomolecular motors; Bio-inspired Nanostructures, Synthesis and characterization of different nanomaterials.

Unit II

Nano – films

5 lectures

Thin films; Colloidal nanostructures; Self Assembly, Nanovesicles; Nanospheres; Nanocapsules and their characterisation.

Unit III

Nano – particles

5 lectures

Nanoparticles for drug delivery, concepts, optimization of nanoparticle properties for suitability of administration through various routes of delivery, advantages, strategies for cellular internalization and long circulation, strategies for enhanced permeation through various anatomical barriers.

Unit IV

Applications of nano–particles

5 lectures

Nanoparticles for diagnostics and imaging (theranostics); concepts of smart stimuli responsive nanoparticles, implications in cancer therapy, nanodevices for biosensor development.

Unit V
Nano–materials
5 lectures

Nanomaterials for catalysis, development and characterization of nanobiocatalysts, application of nanoscaffolds in sythesis, applications of nanobiocatalysis in the production of drugs and drug intermediates.

Unit VI
Nano – toxicity
5 lectures

Introduction to Safety of nanomaterials, Basics of nanotoxicity, Models and assays for Nanotoxicity assessment; Fate of nanomaterials in different stratas of environment; Ecotoxicity models and assays; Life Cycle Assessment, containment.

Recommended Textbooks and References:

1. GeroDecher, Joseph B. Schlenoff, (2003); *Multilayer Thin Films: Sequential Assembly of Nanocomposite Materials*, Wiley-VCH Verlag GmbH & Co. KGaA
2. David S. Goodsell, (2004); *Bionanotechnology: Lessons from Nature*; Wiley-Liss
3. Neelina H. Malsch (2005), *Biomedical Nanotechnology*, CRC Press
4. Greg T. Hermanson, (2013); *Bioconjugate Techniques*, (3rd Edition); Elsevier
5. Recent review papers in the area ofNanomedicine.

Vaccines

Credits
2

Course Objectives

This course will provide students with an overview of current developments in different areas of vaccines.

Student Learning Outcomes

By the end of this course, students should be able to:

- Understand fundamental concepts of human immune system and basic immunology;
- Differentiate and understand immune responses in relation to infection and vaccination;
- Understand requirement and designing of different types of vaccines;
- Understand importance of conventional and new emerging vaccine technologies.

Unit I
Fundamentals of immune system
6 lectures

Overview of Immune system; Human Immune system: Effectors of immune system; Innate & Adaptive Immunity; Activation of the Innate Immunity; Adaptive Immunity; T and B cells in adaptive immunity; Immune response in infection; Correlates of protection.

Unit II
Immune response to infection
9 lectures

Protective immune response in bacterial; viral and parasitic infections; Primary and Secondary immune responses during infection; Antigen presentation and Role of Antigen presenting cells: Dendritic cells in immune response; Innate immune response; Humoral (antibody mediated) responses; Cell mediated responses: role of CD4+ and CD8+ T cells; Memory responses: Memory and effector T and B cells, Generation and Maintenance of memory T and B cells.

Unit III
Immune response to vaccination
8 lectures

Vaccination and immune response; Adjuvants in Vaccination; Modulation of immune responses: Induction of Th1 and Th2 responses by using appropriate adjuvants and antigen delivery systems - Microbial adjuvants, Liposomal and Microparticles as delivery systems; Chemokines and cytokines; Role of soluble mediators in vaccination; Oral immunization and Mucosal Immunity.

Unit IV
Vaccine types & design
3 lectures

History of vaccines, Conventional vaccines; Bacterial vaccines; Viral Vaccines; Vaccines based on routes of administration: parenteral, oral, mucosal; Live attenuated and inactivated vaccine; Subunit Vaccines and Toxoids; Peptide Vaccine.

Unit V

Vaccine technologies

4 lectures

New Vaccine Technologies; Rationally designed Vaccines; DNA Vaccination; Mucosal vaccination; New approaches for vaccine delivery; Engineering virus vectors for vaccination; Vaccines for targeted delivery (Vaccine Delivery systems); Disease specific vaccine design: Tuberculosis Vaccine; Malaria Vaccine; HIV/AIDS vaccine; New emerging diseases and vaccine needs (Ebola, Zika).

Recommended Textbooks and References:

1. Janeway, C. A., Travers, P., Walport, M., & Shlomchik, M. J. (2005). *Immuno Biology: the Immune System in Health and Disease*. USA: Garland Science Pub.
2. Kindt, T. J., Osborne, B. A., Goldsby, R. A., & Kuby, J. (2013). *Kuby Immunology*. New York: W.H. Freeman.
3. Kaufmann, S. H. (2004). *Novel Vaccination Strategies*. Weinheim: Wiley-VCH.
4. Journal Articles (relevant issues) from: Annual Review of Immunology, Annual Review of Microbiology, Current Opinion in Immunology, Nature Immunology, Expert review of vaccines.

Next Generation Communication Systems

COURSE CODE: 18B1WEC745

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Basic knowledge of wireless communication and probability theory

Course Objectives:

1. To analyze the channel parameters effects on communication system.
2. Understanding of advanced techniques employed for improvement of communication system.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Understand the basics of communication system and various standards used in different generation.	Familiarity
CO-2	Understand the modeling of channel used in communication.	Familiarity
CO-3	Analyze the effect of various parameters on the performance of communication system.	Assessment
CO-4	Demonstrate the various techniques for performance improvement of communication system	Assessment
CO-5	Apply advanced techniques to next generation communication system	Usage

Course Contents:

Unit	Contents	Lectures required
1	CDMA: Introduction to various generation of cellular communication systems and standards, Introduction to CDMA and Spread Spectrum, Generation and Properties of PN Sequences, correlation between PN Sequences, Walsh Code, Variable tree OVSF, LFSR, Rake Receiver, Near-Far effect, Multi user CDMA uplink and downlink.	9
2	Channel Characterization of Next generation communication system: BER and SNR analysis of wired and wireless channels, Effect of various channel parameters on performance of wireless communication system, Doppler shift.	6
3	Diversity & Equalization: Diversity System Model, Receiver Diversity: selection diversity, feedback diversity, maximal ratio combining, equal gain combining, Equalizers, Types of Equalizers: linear equalizers, non-linear equalizers.	9
4	Principles of OFDM and MIMO wireless communication: Introduction to OFDM, OFDM Block Diagram, MIMO Wireless Communication, Benefits of MIMO Technology, MIMO OFDM Building Block, Capacity Comparisons of SISO, SIMO, MISO, and MIMO.	9
5	Singular Value Decomposition, Software Defined Radio , Cognitive Radio	9
Total lectures		42

Suggested Text Book(s):

1. T.S. Rappaport, “Wireless Communication”, 2nd Edition, Prentice Hall.,2002.
2. A.Goldsmith, “ Wireless communication” 1st Edition , Cambridge University Press,2005.
3. Ye Li and Gordon L. Stuber, “Orthogonal Frequency Division Multiplexing for Wireless Communications” 1st Edition, Springer, 2006.

Suggested Reference Book(s):

1. Huseyin Arslan: Cognitive Radio, Software Defined Radio, and Adaptive Wireless Systems, 1st Edition, Springer, 2007.

2. Hui Liu, "OFDM based broadband wireless networks: design and optimization" , 1st Edition, John Wiley & Sons, 2006.

Other useful resource(s):

1. Link to NPTEL course contents: https://nptel.ac.in/courses/117104099/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programmed Outcomes (POs)

Course outcomes (Next Generation Communication Systems)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	3	2	2	1	2	2	2	1	2	2	2	1.92
CO-2	3	3	3	3	2	2	1	1	1	2	2	2	2.08
CO-3	3	3	3	3	2	1	1	1	1	2	1	1	1.83
CO-4	2	3	3	2	2	1	1	1	1	2	1	3	1.83
CO-5	3	2	2	2	3	2	2	1	1	2	2	2	2.00
Average	2.6	2.8	2.6	2.4	2	1.6	1.4	1.2	1	2	1.6	2	

Optical Communication Systems

COURSE CODE: 18B1WEC633

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Communication Systems

Course Objectives:

1. To understand the constituents of the fiber optics communication system and optoelectronics.
2. To have an in depth knowledge of practically used optical communication systems

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Understand basics of optical communication systems.	Familiarity
CO-2	The principles that govern optical communication systems.	Familiarity
CO-3	Behavior of light as electromagnetic waves in different types of fibers.	Assessment
CO-4	The hardware components required to implement optical communication systems.	Assessment
CO-5	To efficiently design an optical communication system for practical purpose.	Usage
CO-6	The practical techniques involved in optical communication systems.	Usage

Course Contents:

Unit	Contents	Lectures required
1	Introduction: Fiber optics and Optoelectronics, Historical developments, Fiber optic communication system, Advantages, Emergence as a key technology, Role of Fiber optics technology.	5
2	Ray Propagation in Optical Fibers: Review of fundamental laws of optics, Ray propagation in Step-index and Graded-index Fibers, Effect of material dispersion, The combined effect of multipath and material dispersion, Calculation of rms pulse width.	8
3	Wave propagation in Waveguides: Maxwell's equations, Solution in a inhomogeneous medium, Planar optical waveguide, TE modes of a symmetric step-index planar waveguide, Power distribution and confinement factor, Modal analysis of an ideal SI optical fiber.	8
4	Single-mode Fibers and Multimode Fibers: Single-mode fibers, Characteristics parameters of SMFs, Dispersion in SMFs, Attenuation in SMFs, Graded-index fibers, Limitations of multimode fibers.	7
5	Optoelectronic Sources and Detectors: Fundamental aspects of semiconductor physics, the p-n junction, Current densities and injection efficiency, The basic principle of optoelectronic detection. Types of photodiodes, Photoconducting detectors, Noise considerations.	8
6	Optoelectronic Modulators and Amplifiers: Review of basic principles, Electro-optic modulators, Semiconductor optical amplifiers.	6
Total lectures		42

Suggested Text Book(s):

1. Optical Fiber Communications, John M Senior, 3rd Edition, PHI, 2009.
2. Fiber Optic Communication Systems, Govind P. Agarwal, 4th Edition, Wiley, 2010.
3. Fiber Optics and Optoelectronics, R.P. Khare Oxford University Press, 2015

Suggested Reference Book(s):

1. Fiber Optic Communications, S. Kumar and M. J. Deen, Wiley, 2014.
2. Optical Fiber Communications, G. Keiser, 5th Edition, Tata McGraw Hill, 2009.

Other useful resource(s):

1. Link to NPTEL course contents: https://nptel.ac.in/courses/117101002/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Optical Communication Systems)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	1.75
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	2
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	1.75
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	2.08
CO-5	2	3	3	3	2	1	1	1	2	3	2	2	2.08
CO-6	2	3	3	3	2	1	1	1	2	3	2	2	2.08
Average	2	2.66	2.66	2.66	2.66	1	1	1	2	2.5	1.66	2	

OFDM and Applications

COURSE CODE: 18B1WEC736

COURSE CREDITS: 3

CORE/ELECTIVE: Elective

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

1. Learn the fundamental concepts of high rate OFDM communication system focusing on the physical layer.
2. Analyze the design requirements of various OFDM standards.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Learn the fundamentals of OFDM communication system.	Familiarity
CO-2	Performance analysis of OFDM signals over AWGN and wideband channels.	Assessment
CO-3	Demonstrate the challenging issues in OFDM system.	Assessment
CO-4	Apply OFDM to the practical communication systems.	Usage

Course Contents:

Unit	Contents	Lectures required
1	Introduction and Basics of OFDM: High rate wireless applications; Wireless channel; Interference and noise; OFDM concept and system model- block diagram, design of the OFDM signal, OFDM system model, FFT implementation, cyclic extension, power spectrum and spectrum efficiency, synchronization errors; Channel capacity and OFDM; Comparison with single-carrier; Design example; Performance of an uncoded OFDM system.	10
2	Impairments of Wireless Channels to OFDM Signals: Time varying impairments; Effect of sampling clock offset; Effect of timing offset; Effect of delay spread; System Non Linearity. Other Multicarrier Modulation; Mathematical modeling and analytical evaluation of the BER of OFDM System.	8
3	OFDM Transmission over Gaussian channels and wideband channels. Synchronization: Overview of synchronization schemes- timing offset estimation, frequency offset estimation, acquisition versus tracking; Timing offset estimation-pilot based methods, non-pilot based methods; Frequency offset estimation- pilot based methods, non-pilot based methods; Joint time and frequency offset estimation and correction.	8
4	OFDM versus-MC-CDMA Peak Power Ratio: The peak power problem; Distribution of PAP ratio; Maximum PAPR of an N subcarrier OFDM signal; PAPR reduction with signal distortion; Limits for distortion-less PAPR-reduction; Techniques for distortion-less PAPR reduction-selective mapping, optimization techniques, modified signal constellation; PAPR reduction effect on the system performance; PAPR reduction for multicarrier CDMA.	8
5	OFDM applications: MIMO OFDM- synchronization for MIMO OFDM, A practical OFDM system: Fixed broadband wireless access, system requirements, parameter selection, communication protocol, frame structure, MAC consideration and conformance.	8
Total lectures		42

Suggested Text Book(s):

1. Ye Li and Gordon L. Stuber: Orthogonal Frequency Division Multiplexing for Wireless Communications,

1st Edition, Springer, 2006.
2. Ramjee Prasad: OFDM for Wireless Communications Systems, 1st Edition, Artech House Publishers, 2004.
3. Lazos Hanzo: OFDM and MC-CDMA: A primer, 1st Edition, Wiley-IEEE Press, 2006

Suggested Reference Book(s):

1. Richard Van Nee: OFDM for Wireless Multi-Media Communication, 1st Edition, Artech, House Publishers, 2000.
2. Hui Liu: OFDM based Broadband Wireless Networks: Design and Optimization, 1st Edition, John Wiley & Sons, 2006.

Other useful resource(s):

1. Link to NPTEL course contents: https://nptel.ac.in/courses/117104099/
2. Link to topics related to course:
   https://nptel.ac.in/courses/117104099 /27
   https://nptel.ac.in/courses/117104099 /28
   https://nptel.ac.in/courses/117104099 /29
   https://nptel.ac.in/courses/117104099 /30
   https://nptel.ac.in/courses/117104099 /31
   https://nptel.ac.in/courses/117104099 /34

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (OFDM and its Applications)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	2	3	1	3	1	1	1	2	2	1	3	1.92
CO-2	3	3	3	3	3	2	1	1	2	2	1	3	2.25
CO-3	2	2	3	3	2	1	1	1	2	1	1	3	1.83
CO-4	2	1	3	3	3	2	1	1	1	1	1	2	1.75
Average	2.5	2	3	2.5	2.75	1.5	1	1	1.75	1.5	1	2.75	

Optimization Techniques

COURSE CODE:

COURSE CREDITS: 3

CORE/ELECTIVE: Elective

L-T-P: 3-0-0

Pre-requisite: Basics of engineering mathematics Course Objectives:

1. To lay strong foundations in understanding the importance of optimization techniques.
2. To apply the theoretical knowledge acquired to various applications.
3. To analyze and appreciate variety of performance measures for various optimization problems.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	To formulate and solve linear programming problems.	Familiarity
CO-2	To solve the problems on networks models such as Transportation, Assignment, Shortest path, minimal spanning tree, and Maximal flow.	Usage
CO-3	To solve the problems of Project Management using CPM and PERT	Usage
CO-4	Solve Non-linear Programming problems of some kinds.	Familiarity and Usage

Course Contents:

Unit	Contents	Lectures required
1	Introduction to Operation Research: Operation Research approach, scientific methods, introduction to models and modeling techniques, general methods for Operation Research models, methodology and advantages of Operation Research, history of Operation Research.	8
2	Linear Programming (LP): Introduction to LP and formulation of Linear Programming problems, Graphical solution method, alternative or multiple optimal solutions, Unbounded solutions, Infeasible solutions, Maximization – Simplex Algorithm, Minimization – Simplex Algorithm using Big-M method, Two phase method, Duality in linear programming, Integer linear programming.	8
3	Transportation & Assignment Problems: Introduction to Transportation problems, various methods of Transportation problem, Variations in Transportation problem, introduction to Assignment problems, variations in Assignment problems.	6

4	Network Analysis: Network definition and Network diagram, probability in PERT analysis, project time cost trade off, introduction to resource smoothing and allocation.Sequencing: Introduction, processing N jobs through two machines, processing N jobs through three machines, processing N jobs through m machines.	8
5	Inventory Model: Introduction to inventory control, deterministic inventory model, EOQ model with quantity discount.	6
6	Non-Linear Programming: Characteristics, Concepts of convexity, maxima and minima of functions of n-variables using Lagrange multipliers and Kuhn-Tuker conditions, One dimensional search methods, Fibonacci, golden section method and gradient methods for unconstrained problems.	6
Total lectures		42

Suggested Text Book(s):

1. J K Sharma, Operations Research Theory and Applications, MacMillan India Ltd.
2. N D Vohra, Quantitative Techniques in management, Tata McGraw Hill.
3. Handy A Taha, Operations Research – An Introduction, Prentice Hall of India, New Delhi.

Suggested Reference Book(s):

1. Wagner H M, Principles of Operations Research: With Applications to Management Decisions, Prentice-Hall of India, New Delhi.
2. Hillier F S and Lieberman G J, Operations Research, Holden Day Inc., San Francisco.
3. Payne T A, Quantitative Techniques for Management: A Practical Approach, Reston Publishing Co. Inc., Virginia.
4. Wilkes F M, Baum P and Smith G D, Management Science: An introduction, John Wiley and Sons, Santa Barbara.

Other useful resource(s):

1. Link to NPTEL course contents: https://nptel.ac.in/courses/111/105/111105039/ https://nptel.ac.in/courses/105/108/105108127/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Optimization Techniques)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	2	1	1	1	2	1	2	1.7
CO-2	2	3	2	3	2	2	1	1	1	2	1	2	1.8
CO-3	3	3	3	3	3	2	1	1	1	2	1	2	2.1
CO-4	2	2	2	2	2	2	1	1	1	3	1	2	1.8
Average	2.25	2.5	2.25	2.5	2.25	2.0	1.0	1.0	1.0	2.25	1.0	2.0	

11. Isolation and identification of bacteria from soil/water samples.

Recommended Textbooks and References:

1. Cappuccino, J. G., & Welsh, C. (2016). *Microbiology: a Laboratory Manual.* Benjamin-Cummings Publishing Company.
2. Collins, C. H., Lyne, P. M., Grange, J. M., & Falkinham III, J. (2004). *Collins and Lyne's Microbiological Methods* (8th ed.). Arnolds.
3. Tille, P. M., & Forbes, B. A. *Bailey & Scott's Diagnostic Microbiology.*

Laboratory III: Plant and Animal Biotechnology

Credits

2

Course Objectives

The objectives of this course are to provide hands-on training in basic experiments of plant and animal biotechnology.

Student Learning Outcomes

On completion of course, students should be able to gain basic skills in plant and animal biotechnology.

Syllabus

Plant Biotechnology

1. Prepare culture media with various supplements for plant tissue culture.
2. Prepare explants of *Valleriana wallichii* for inoculation under aseptic conditions.
3. Attempt *in vitro* andro and gynogenesis in plants *(Datura stramonium)*.
4. Isolate plant protoplast by enzymatic and mechanical methods and attempt fusion by PEG (available material).
5. Culture *Agrobacterium tumefaciens* and attempt transformation of any dicot species.
6. Generate an RAPD and ISSR profile of *Eremurus persicus* and *Valleriana wallichii.*
7. Prepare karyotypes and study the morphology of somatic chromosomes of *Allium cepa, A. sativum, A. tuberosum* and compare them on the basis of karyotypes.
8. Pollen mother cell meiosis and recombination index of select species (one achiasmate, and the other chiasmate) and correlate with generation of variation.
9. Undertake plant genomic DNA isolation by CTAB method and its quantitation by visual as well as spectrophotometeric methods.
10. Perform PCR amplification of 'n' number of genotypes of a species for studying the genetic variation among the individuals of a species using random primers.
11. Study genetic fingerprinting profiles of plants and calculate polymorphic information content.

Syllabus

Animal Biotechnology

1. Count cells of an animal tissue and check their viability.
2. Prepare culture media with various supplements for plant and animal tissue culture.
3. Prepare single cell suspension from spleen and thymus.
4. Monitor and measure doubling time of animal cells.
5. Chromosome preparations from cultured animal cells.
6. Isolate DNA from animal tissue by SDS method.
7. Attempt animal cell fusion using PEG.

Pattern Analysis in Machine Intelligence

COURSE CODE: XXXXXXXX

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite:

None

Course Objectives:

1. To introduce the concept of patterns for data analysis.
2. To analyze patterns to make machine take some decision.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Understand the concept and representation of patterns in different data.	Familiarity
CO-2	Understand and able to visualize the concept and methodology of different feature extraction and feature selection methods.	Usage
CO-3	Able to understand the methodology of different classifiers.	Assessment
CO-4	Understand the concept of unsupervised learning for pattern recognition.	Assessment
CO-5	Able to implement different classifiers and their combinations for different applications.	Usage

Course Contents:

Unit	Contents	Lectures required
1	Introduction: Definitions, data sets and Different Paradigms of Pattern Recognition, Representations of Patterns and Classes.	6
2	Feature Extraction and Selection: Metric and non-metric proximity measures, Feature extraction and different approaches to Feature Selection.	12
3	Introduction to Supervised learning: Bayes Classifier, Decision Trees, Linear Discriminant Function and Support Vector Machines.	12
4	Introduction to Unsupervised learning: Clustering Methods	6
5	Combination of Classifiers for different applications.	6
Total lectures		42

Suggested Text Book(s):

1. R. O. Duda, P.E. Hart and D. G.Stork,,"Pattern Classification", 2nd Ed., Wiley, 2000.
2. H. Simon, "Neural Networks and Learning Machines",3rd ed., Prentice Hall, 2009.

Suggested Reference Book(s):

1. Jiawei Han, Jian Pei, Micheline Kamber, "Data Mining: Concepts and Techniques", 3rd ed., Elsevier Amsterdam, 2011.
2. C. Bishop, "Pattern Recognition and Machine learning", 1st ed., Springer, 2006.

Other useful resource(s):

1. https://nptel.ac.in/courses/117105101/ (Prof P.K. Biswas, IIT Kharagpur)
2. http://www.cs.ucsb.edu/~yfwang/courses/cs290i_prann/index.html (Prof. Yuan-Fang Wang)

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes(2) -10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Pattern Recognition in Machine Intelligence)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	2	3	3	1	1	1	1	3	1	3	2.2
CO-2	3	3	3	3	3	1	1	1	2	3	1	3	2.2
CO-3	3	3	3	3	3	2	2	2	2	3	1	3	2.5
CO-4	3	3	3	3	3	2	2	2	2	3	1	3	2.5
CO-5	3	3	3	3	3	2	2	2	2	3	2	3	2.6
Average	3	3	2.8	3	3	1.6	1.6	1.6	1.8	3	1.2	3	

15. Guidelines for Safety Assessment of Foods Derived from Genetically Engineered Plants. 2008.
16. Guidelines and Standard Operating Procedures for Confined Field Trials of Regulated Genetically Engineered Plants. 2008. Retrieved from http://www.igmoris.nic.in/guidelines1.asp
17. Alonso, G. M. (2013). *Safety Assessment of Food and Feed Derived from GM Crops: Using Problem Formulation to Ensure "Fit for Purpose" Risk Assessments.* Retrieved from http://biosafety.icgeb.org/inhousepublicationscollectionbiosafetyreviews.

Project Proposal Preparation & Presentation

Credits

2

Course Objectives

The purpose of this course is to help students organize ideas, material and objectives for their dissertation and to begin development of communication skills and to prepare the students to present their topic of research and explain its importance to their fellow classmates and teachers.

Student Learning Outcomes

Students should be able to demonstrate the following abilities:

- Formulate a scientific question;
- Present scientific approach to solve the problem;
- Interpret, discuss and communicate scientific results in written form;
- Gain experience in writing a scientific proposal;
- Learn how to present and explain their research findings to the audience effectively.

Syllabus

Project Proposal Preparation

Selection of research lab and research topic: Students should first select a lab wherein they would like to pursue their dissertation. The supervisor or senior researchers should be able to help the students to read papers in the areas of interest of the lab and help them select a topic for their project. The topic of the research should be hypothesis driven.
Review of literature: Students should engage in systematic and critical review of appropriate and relevant information sources and appropriately apply qualitative and/or quantitative evaluation processes to original data; keeping in mind ethical standards of conduct in the collection and evaluation of data and other resources.
Writing Research Proposal: With the help of the senior researchers, students should be able to discuss the research questions, goals, approach, methodology, data collection, *etc.* Students should be able to construct a logical outline for the project including analysis steps and expected outcomes and prepare a complete proposal in scientific proposal format for dissertation.

Syllabus

Poster Presentation

Students will have to present the topic of their project proposal after few months of their selection of the topic. They should be able to explain the novelty and importance of their research topic.

Syllabus

Oral Presentation

At the end of their project, presentation will have to be given by the students to explain work done by them in detail. Along with summarizing their findings they should also be able to discuss the future expected outcome of their work.

RF Engineering

COURSE CODE: 18B1WEC848

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Basic knowledge of Electromagnetic Engineering

Course Objectives:

1. To lay strong foundations in RF and microwave engineering.
2. To apply the theoretical knowledge acquired in the design of different components in microwave systems.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	To have a thorough knowledge of RF and microwave components	Familiarity
CO-2	To have a thorough knowledge about different parameters involved in microwave receiver and their significance	Assessment
CO-3	To have a thorough knowledge about different parameters involved in microwave receiver and their significance	Assessment
CO-4	To design different RF filters according to certain specifications	Usage
CO-5	To understand active microwave components and their use in different applications	Usage

Course Contents:

Unit	Contents	Lectures required
1	Review of Waves and Transmission Lines: Wave Propagation, Transmission Line Equations, Reflection, Transmission, and impedance for a Terminated Transmission Line, Voltage Standing-Wave Ratio, Decibels, insertion Loss, Return Loss, Smith Charts, S-Parameters, Impedance Matching Networks.	5
2	Receiver System Parameters: Typical Receivers, System Considerations, Natural Sources of Receiver Noise, receiver Noise Figure and Equivalent Noise Temperature, Compression Points, Minimum detectable Signal and Dynamic Range, Third-Order Intercept Point and Intermodulation, spurious Responses, Spurious-Free Dynamic Range	8
3	Transmitter and Oscillator Systems: Transmitter Parameters, Transmitter Noise, Frequency Stability and Spurious Signals, Frequency Tuning, Output Power, and Efficiency, Intermodulation, Crystal Reference Oscillators, Phase-Locked Oscillators, frequency Synthesizers	6
4	Design of RF filters: Periodic Structures, Filter Design by the Image Parameter Method, Filter Design by the Insertion Loss Method, Characterization by Power Loss Ratio Filter transformations, Filter Implementation, Stepped-Impedance Low-Pass	9
5	Fabrication Technologies: Lumped Elements for RF circuits: Basic Design of Lumped elements, Lumped element modeling, printed inductors, MIM capacitor and Interdigital capacitor, Monolithic Integrated circuit technology (MIC), Monolithic microwave integrated circuit (MMIC) technology, material, RF printed circuit boards.	9
6	Wireless Communication Systems: Friis Transmission Equation, Space Loss, Link Equation and Link budget, Effective Isotropic Radiated Power and G/T Parameters, Radio/Microwave Links, Satellite Communication Systems, Mobile Communication Systems and Wireless cellular phones, Personal Communication Systems	5
Total lectures		42

Suggested Text Book(s):

1. Kai Chang, "RF and Microwave Wireless Systems",1st Edition, John Wiley & Sons, 2002.
2. Pozar, David M. "Microwave engineering", 4th Edition, John Wiley & Sons, 2013.
3. Bahl I.J "Lumped Elements for RF and Microwave Circuits"1st Edition, Artech House,2003.

Suggested Reference Book(s):

1. R.E.Collin, "Foundations for microwave Engineering", 2nd Edition, John Wiley & Sons, 2007.
2. Annapurna Das, Sisir.K.Das, "Microwave Engineering",1st Edition, Tata McGraw Hill, 2000.

Other useful resource(s):

Link to NPTEL course contents:

https://nptel.ac.in/courses/117101119/

https://nptel.ac.in/courses/117105138/

Link to topics related to course:

https://nptel.ac.in/courses/117105138/ 1 to 18

https://nptel.ac.in/courses/117101119/ 1 to 14

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (RF Engineering)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	2	1	1	1	2	1	2	1.7
CO-2	2	3	2	3	2	2	1	1	1	2	1	2	1.8
CO-3	3	3	3	3	3	2	1	1	1	2	1	2	2.1
CO-4	2	2	2	2	2	2	1	1	1	3	1	2	1.8
CO-5	3	2	3	2	2	2	1	1	1	2	1	2	1.8
Average	2.4	2.4	2.4	2.4	2.2	2.0	1.0	1.0	1.0	2.2	1.0	2.0	

RF Integrated Circuits

COURSE CODE:

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives: This course will develop electronic circuits for radio frequency applications, specific to CMOS integrated circuits

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Introduction to CMOS integrated circuits specific to radio frequencies.	Familiarity
CO-2	Design of circuits for radio frontends for mobile phone handsets.	Usage
CO-3	Learn to design low noise amplifiers and mixer circuits.	Usage
CO-4	Applications of voltage controlled oscillators and phase locked loops, power amplifier in the design of modern radio architecture.	Assessment

Course Contents:

Unit	Contents	Lectures required
1.	Introduction:RF systems-basic architectures, Transmission media and reflections, Maximum power transfer, Passive RLC Networks:Parallel RLC tank, Series RLC networks, matching, Pi match, T match, MOS device review	6
2.	Passive IC components: Resistors, capacitors, inductors, wires and transmission lines	6
3.	High Frequency Amplifier Design: Bandwidth estimation using open-circuit time constants, Bandwidth estimation using short-circuit time constants, Rise time, delay and bandwidth, Zeros to enhance bandwidth, Shunt-series amplifiers, tuned amplifiers, Cascaded amplifiers. Noise: Thermal noise, flicker noise review, Noise figure, phase noise general consideration	7
4.	Low noise amplifiers and Mixer design: Intrinsic MOS noise parameters, Power match versus noise match, Large signal performance, Multiplier based mixers, multiplier fundamentals, Subsampling mixers	6
5.	Voltage controlled oscillator: A tank based oscillators, phase in oscillators, Resonators, Negative resistance oscillators,	5

6.	Phase locked loops:Phase locked loop basics, charge pump, PLL dynamics integer, Spurious frequencies fractional and synthesis, Fractional spurs, Delta and sigma modulation	6
7.	RF Power Amplifiers: Class abc power amplifiers, Class bcd power amplifiers and Class cd pwm amplifiers	6
Total lectures		42

Suggested Text Book(s):

1. T. H. Lee, "The Design of CMOS Radio-Frequency Integrated Circuits", Cambridge University Press, 2004.
2. B. Razavi, "RF Microelectronics", Prentice Hall, 1997
3. B. Christopher, "RF circuit design", Elsevier, 2011

Other useful resource(s):

1. NPTEL online course: https://nptel.ac.in/courses/117/102/117102012

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes(2) -10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course Outcomes (RF Integrated Circuits)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO1	2	1	3	3	3	2	1	1	1	1	1	1	1.67
CO2	3	3	3	2	2	2	1	1	3	3	2	3	2.33
CO3	3	3	3	3	2	2	1	1	3	2	2	3	2.33
CO4	3	3	3	3	2	2	1	1	3	2	2	2	2.25
Average	2.75	2.50	3.00	2.75	2.25	2.00	1.00	1.00	2.50	2.00	1.75	2.25	

Remote Sensing and Satellite Image Processing

COURSE CODE:

COURSE CREDITS: 3

CORE/ELECTIVE: Elective

L-T-P: 3-0-0

Pre-requisite: None.

Course Objectives: To provide basic understanding about satellite based Remote Sensing and analyses Satellite Image Processing techniques.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	To lay foundations in understanding the concepts of remote sensing.	Familiarity
CO-2	To lay foundations in analyzing the images obtained from satellites	Usage
CO-3	To apply the theoretical knowledge acquired to various applications.	Usage
CO-4	To understand about different imaging techniques and their applications	Familiarity and Usage

Course Contents:

S. No	Topics	Classes
1	Remote Sensing: Basics of Remote Sensing: Overview of Remote sensing: Definition of Remote sensing, Principles of Remote Sensing, Electromagnetic Radiation, Radiometric terms and definitions, Radiation Laws, EM spectrum, Sources of EM, Interaction of EM Radiation with atmosphere, and target, Atmospheric Widows, imaging spectrometry, Spectral signature of various land cove features Platforms and sensors: Platforms: Types of platforms, ground, airborne, and space born platforms, Orbit of satellites, Kepler's Law, satellite characteristics, satellites for Earth observations studies, and planetary missions (Chandrayana) Sensors: Types and classification of sensors, imaging modes, Characteristics of optical sensors, sensor resolution-spectral, radiometric and temporal, Characteristics of detectors.	8
2	Data reception, Data processing & Data generation: Ground station, Data generation, Data processing & correction, Radiometric and Geometric corrections, Radiometric corrections, Random noise correction, Atmospheric correction, Geometric errors and corrections, Distortion evaluated from tracking data, distortion evaluated from ground control Image correction. Ground Investigation in support of Remote sensing, Uses of ground data, calibration correction, Interpretation of properties, Training sets, Accuracy evaluation, test	8

	sites, Ground truth Instruments and spectral signature, Spectral Reflectance and spectral signature of vegetation, Sources of RS data: Global and Indian data products	
3	Visual Image Interpretation: Introduction to Visual Interpretation, Basic principles of Visual Interpretation, Elements of Visual Interpretation, Techniques of Visual Interpretation, Interpretation Keys, Methods of searching and sequence of Interpretation, Methods of analysis and Reference levels, Computer compatible tapes – Band sequential format, Band interleaved by Line format, Run-length encoding format. Hardcopy outputs – Generation of B/W and False Color Composites. Generally supported scales of the data products, Information about annotation of the products.	9
4	Thermal Imaging system: Thermal Imaging System: Introduction - IR region of the Electromagnetic spectrum, Atmospheric transmission, Kinetic and radiant temperature, Thermal properties of materials, Emissivity, Radiant temperature. Thermal conductivity. Thermal capacity, thermal inertia, apparent thermal inertia, Thermal diffusivity. Radiation principles (Plank's Law, Stephen Boltzman law), Interaction of EMR with earth surface, Wien's displacement law, Kirchoffs Law).IR - radiometers, Airborne and Satellite TTR scanner system Characteristics of IR images, Scanner distortion, image irregularities, Film density and recorded ,Temperature ranges, Effects of weather on images, Clouds, Surface winds, Penetration of smoke plumes, Interpretation of thermal imagery, Advantages of Thermal imagery	9
5	Microwave Remote Sensing: Introduction - Electromagnetic spectrum, Airborne and Space borne radar systems basis instrumentation. System parameters - Wave length, Polarization, Resolutions, Radar geometry. Target parameters - Back scattering, Point target, Volume scattering, Penetration, Reflection, Bragg resonance, Cross swath variation. Speckle radiometric calibration. Microwave sensors and Image characteristics, Microwave image interpretation, Application : Geology, Forestry, Land use, Soils etc. Future trends and Research, Physics of lager, laser interaction with objects. Types of LiDAR, platforms of LiDAR, components of LiDAR.	8

Suggested Text Book(s):

1. Sabins Jr, Floyd F. *Remote sensing--principles and interpretation*. WH Freeman and company, 1987.
2. Lillesand, Thomas, Ralph W. Kiefer, and Jonathan Chipman. *Remote sensing and image interpretation*. John Wiley & Sons, 2015.
3. Davis, Shirley M., et al. "Remote sensing: the quantitative approach." *mhi* (1978).
4. Jensen, John R. *Introductory digital image processing: a remote sensing perspective*. No. Ed. 2. Prentice-Hall Inc., 1996.
5. Trevett, J. William. *Imaging radar for resources surveys*. Springer Science & Business Media, 2013.

Suggested Reference Book(s):

1. Mather, Paul M., and Magaly Koch. *Computer processing of remotely-sensed images: an introduction*. John Wiley & Sons, 2011.
2. Schowengerdt, Robert A. *Remote sensing: models and methods for image processing*. Elsevier, 2006.

Other useful resource(s):

1. Link to NPTEL course contents: https://nptel.ac.in/courses/105/108/105108077/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Optimization Techniques)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	2	1	1	1	2	1	2	1.7
CO-2	2	3	2	3	2	2	1	1	1	2	1	2	1.8
CO-3	3	3	3	3	3	2	1	1	1	2	1	2	2.1
CO-4	2	2	2	2	2	2	1	1	1	3	1	2	1.8
Average	2.25	2.5	2.25	2.5	2.25	2.0	1.0	1.0	1.0	2.25	1.0	2.0	

Real Time Operating Systems

COURSE CODE: XXXXXXXX

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Prerequisites are basic knowledge of computer architecture and operating systems

Course Objectives:

1. Study of design of real time operating systems and their operations.
2. Design and analysis of real time system software.
3. Modeling and verification of real time systems
4. Use real time system programming languages and real time operating systems for real time applications.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Fundamental principles for programming of real time systems with time and resource limitations.	Familiarity
CO-2	Foundation for programming languages developed for real time programming.	Assessment
CO-3	How real time operating systems are designed and functions.	Assessment
CO-4	Study of application domains.	Usage

Course Contents:

Unit	Contents	Lectures required
1	Introduction to UNIX/LINUX, Overview of Commands, File I/O,(open, create, close, lseek, read, write), Process Control (fork, vfork, exit, wait, waitpid, exec).	8
2	Brief History of OS, Defining RTOS, The Scheduler, Objects, Services, Characteristics of RTOS, Defining a Task, asks States and Scheduling, Task Operations, Structure, Synchronization, Communication and Concurrency. Defining Semaphores, Operations and Use, Defining Message Queue, States, Content, Storage, Operations and Use	8
3	Pipes, Event Registers, Signals, Other Building Blocks, Component Configuration, Basic I/O Concepts, I/O Subsystem	7
4	Exceptions, Interrupts, Applications, Processing of Exceptions and Spurious Interrupts, Real Time Clocks, Programmable Timers, Timer Interrupt Service Routines (ISR), Soft Timers, Operations.	7

5	RT Linux, Micro C/OS-II, Vx Works, Embedded Linux, and Tiny OS.	6
6	Fault – Tolerant Design: A Case Study, Case Study in Software Requirements Specification for Four way, Traffic Intersection Traffic Light Controller System.	6
Total lectures		42

Suggested Text Book(s):

1. Qing Li, "Real Time Concepts for Embedded Systems", 2011, Elsevier.

Suggested Reference Book(s):

1. Rajkamal, "Embedded Systems- Architecture, Programming, and Design", 2007, TMH.
2. W. Richard Stevens, Stephan A. Rago, "Advanced UNIX Programming", 2006, 2nd Edition, Pearson.
3. Dr. Craig Hollabaugh, "Embedded Linux: Hardware, Software and Interfacing", 2008, 1st Edition, Pearson.

Other useful resource(s):

Link to topics related to course:

1. https://nptel.ac.in/courses/106/105/106105172/
2. https://onlinecourses.nptel.ac.in/noc20_cs16/preview

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Real Time Operating Systems)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	3	3	2	1	1	1	2	2	2	2	1.91
CO-2	3	3	3	3	3	2	1	1	3	2	1	3	2.33
CO-3	2	3	2	2	2	2	2	2	2	2	1	2	2.00
CO-4	3	3	3	3	2	1	1	1	2	3	2	3	2.25
Average	2.50	2.75	2.75	2.75	2.25	1.50	1.25	1.25	2.25	2.25	1.50	2.50	

Soft Computing Techniques

COURSE CODE: 18B1WEC851

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

1. Develop the skills to gain a basic understanding of neural network theory and fuzzy logic theory.
2. Introduce students to artificial neural networks and fuzzy theory from an engineering perspective

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Comprehend the fuzzy logic and the concept of fuzziness and concepts of neural networks	Familiarity
CO-2	Demonstrate knowledge representation using fuzzy rules, approximate reasoning, fuzzy inference systems, and fuzzy logic	Assessment
CO-3	Understand appropriate learning rules for each of the architectures and learn several neural network paradigms and its applications	Assessment
CO-4	Apply fuzzy rules and neural network learning rules and design paradigms to solve engineering and other Problems.	Usage

Course Contents:

Unit	Contents	Lectures required
1	Introduction to fuzzy set theory: Probabilistic reasoning, Fuzzy sets, mathematics of fuzzy set theory, operations on fuzzy sets, comparison of fuzzy and crisp set theory.	4
2	Fuzzy mapping: one to one mapping, max-min principle, extension principle, implication rules – mamdani implications. Membership functions: Universe of discourse, mapping inside fuzzy domain, fuzzy membership mapping methods, and application to real world problems.	10
3	Artificial Neural Networks (ANN) and their biological roots and motivations. Comparison Between Artificial and Biological Neural Networks, Applications of Neural network. Network Architecture ,Taxonomy of neural networks: feed forward and recurrent networks with. Merits and limitations of neurocomputing.	8
4	Types of learning, supervised and unsupervised learning laws . Learnig Laws : Hebb's rule, Delta rule, Widrow - Hoff (The Least-Mean-Square) learning rule, correlation learning rule, instar and outstar learning rules, Competitive learning, Credit Assignment Problem, Error Correction learning, Memory based learning.	9
5	The Perceptron and its learning law, Classification of linearly separable patterns, Multi-Layer Perceptron, Supervised Learning, Back-Propagation Learning law. Feed forward networks, Recurrent Networks.	6
6	Winner takes-all Networks, Competitive Learning, Kohonen's Self organizing Maps, Introduction to Adaptive Resonance Theory.	5
Total lectures		42

Suggested Text Book(s):

1. Simon Haykin: Artificial Neutral Networks, 2nd Edition, Pearson, 2008.
2. Yegna Narayanan: Artificial Neural Networks, 2nd Edition, Prentice-Hall of India, 2010.
3. S.N. Sivanandam, S.N Deepa: Principles of Soft Computing, 3rd Edition, Wiley, 2019.

Approved in Academic Council held on 25.10.2018

Suggested Reference Book(s):

1. Bart Kosko: Neural Network and Fuzzy Systems: A Dynamic System Approach to Machine, Prentice-Hall 1998
2. L. Fausett: Fundamentals of Neural Networks: Architectures, Algorithms, and Applications, Prentice-Hall, Reprint 2013
3. Jack M. Zurada: Introduction to Artificial Neural Systems, PWS Publishing Co., 2nd Edition, 2002.

Other useful resource(s):

Link to NPTEL course contents

1. http://nptel.ac.in/courses/117105084/
2. http://nptel.ac.in/courses/108104049/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Soft Computing Techniques)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	2	2	2	3	2	1	1	1	2	2	2	1.92
CO-2	3	2	3	3	3	1	1	1	1	2	2	2	2.00
CO-3	3	2	3	3	3	2	1	1	1	2	2	2	2.08
CO-4	3	3	3	3	3	2	3	1	1	3	3	3	2.58
Average	3	2.25	2.75	2.75	3	1.75	1.5	1	1	2.25	2.25	2.25	2.15

Statistical Signal Processing

COURSE CODE: XXXXXXX

COURSE CREDITS: 3

CORE/ELECTIVE: Elective

L-T-P: 3-0-0

Pre-requisite: Principles of Digital Signal Processing (18B11EC511)

Course Objectives:

1. To understand signal models, signal characterization, and spectral estimation.
2. To understand, theory, implementation, and applications of statistical signal processing methods.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Able to understand the autoregressive, moving average, autoregressive moving average, and general linear models and how they relate to signal processing	Familiarity
CO-2	Able to apply wiener filter and adaptive filter for filtering and noise cancellation.	Usage
CO-3	Able to apply nonparametric techniques for spectral estimation	Usage
CO-4	Able to understand the cross-power spectral density, coherence, and apply time-frequency analysis tools for different application.	Familiarity & Usage
CO-5	Able to implement and apply these skills for different applications or projects.	Assessment

Course Contents:

S. No.	Contents	Contact Hours
1.	Introduction, Discrete-Time Processing, Discrete-Time Systems, Random Variables, Stochastic Signals, Estimation Theory, Signal Models, Autocorrelation, Windowing, IMPLEMENTATION IN PYTHON OR MATLAB	6
2	Linear Estimation, Optimum FIR Filters, Linear Prediction, Optimum IIR Filters, Optimum Linear Filter Applications, Kalman Filter, Extended Kalman Filter, Least-Squares Estimation, Implementation in PYTHON OR MATLAB.	8
3	Spectral Estimation, Non-Parametric Methods, Minimum Variance Spectrum Estimation, Maximum Entropy Method, Frequency Estimation Method, Parametric Methods, Principal Component Spectrum Estimation Method, Implementation in PYTHON OR MATLAB.	16
4	Joint Signal Analysis, Coherence Analysis, Time-Frequency Analysis, Implementation in PYTHON OR MATLAB.	8
5.	Adaptive Filtering, FIR Adaptive Filter, Implementation in PYTHON or MATLAB.	4
	Total	42

Suggested Text Book(s):

1. M. H. Hayes, Statistical Digital Signal Processing and Modelling, John Wiley & Sons, Student Edition, 2013.
2. D.G. Manolakis, V.K. Ingle and S.M. Kogon: Statistical and Adaptive Signal Processing, Artech House publishers, 2005.

Suggested Reference Book(s):

1. John G, Charles M. Algorithms for statistical signal processing. Prentice Hall, London; 2002.
2. Simon Haykin, Adaptive Filter Theory, Prentice Hall, 1996

Other useful resource(s):

1. https://nptel.ac.in/courses/108/103/108103158/#
2. http://web.cecs.pdx.edu/~ssp/
3. http://www.eas.uccs.edu/~mwickert/ece5615/lecture_notes/
4. http://www.eas.uccs.edu/~mwickert/ece5615/lecture_notes/N5615_1.pdf

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered up to T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Statistical Signal Processing)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	2	2	2	3	3	2	3	3	3	3	3
CO-2	3	3	3	3	3	3	3	3	3	3	3	3	3
CO-3	3	3	3	3	3	2	3	3	2	3	3	3	3
CO-4	3	3	3	3	3	3	2	3	3	3	3	3	3
CO-5	3	3	3	3	3	3	3	3	3	3	3	3	3
Average	3	3	2.8	2.8	2.8	2.8	2.8	2.8	2.8	3	3	3	

Switching Theory and Logic Design

COURSE CODE: COURSE

CREDITS: 3

CORE/ELECTIVE: ELECTIVE L-T-P:

3-0-0

Pre-requisite: None

Course Objectives:

1. To make the students understand the concepts of digital circuits.
2. To design complex digital circuits based on the given requirement.
3. Understand the programming of digital circuits using VHDL.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Understand the basic concepts of digital circuits.	Familiarity
CO-2	Learn about different the basic principles used in the working of digital circuits.	Familiarity
CO-3	Understand various hazards encountered in designing these circuits.	Assessment
CO-4	Learn to write programs using VHDL.	Usage

Course Contents:

Unit	Contents	Lectures required
1	Introduction to Digital Circuits: Design of combinational circuits, Quine- McCluskey method, sequential machine fundamentals - the need, concept of memory, Flip flops, sequential machine operations, classifications. Switching Circuits. Logic families: TTL, nMOS, CMOS, dynamic CMOS. Logic design using ROMs, PLAs and FPGAs. Case studies	5
2	Design of Synchronous Sequential Circuits: Sequential circuits, Finite state model – Basic definition, capabilities and limitation of finite state machines, state equivalence & machine minimization, simplification of incompletely specified machines, Extraction of maximal compatibles, synthesis & analysis of synchronous sequential circuits.	8
3	Design of Asynchronous Sequential Circuits: Introduction to asynchronous circuits, timing diagram, state diagram & flow tables, types of asynchronous circuits, fundamental mode circuits, pulse mode circuits, state assignment in asynchronous sequential circuits, Synthesis and analysis, ASM charts: Representation of sequential circuits using ASM charts.	8

4	Hazards and Races: Introduction, gate delays, generation of spikes, production of static hazards in combinational networks, elimination of static hazards, design of hazard free combinational networks, hazard free asynchronous circuit design, dynamic hazards, essential hazards, Races and Cycles.	9
5	VHDL/Verilog HDL: Verilog as HDL, Levels of Design Description, Concurrency, Simulation and Synthesis, Functional Verification, System Tasks, Programming Language Interface (PLI), Module, Simulation and Synthesis Tools, Test Benches. Language constructs and conventions: Introduction, Keywords, Identifiers, White Space Characters, Comments, Numbers, Strings, Logic Values, Strengths, Data Types, Scalars and Vectors, Parameters, Memory, Operators, System Tasks, Exercises.	12
Total lectures		42

Suggested Text Book(s):

1. Switching and Finite Automata Theory, ZVI Kohavi, Third Edition, Cambridge University Press.
2. John M Yarbrough : Digital Logic Applications and Design, 2nd Edition, Thomson Education
3. W. I. Fletcher :An Engineering approach to Digital Design , PHI

Suggested Reference Book(s):

1. Digital Systems Design using VHDL – Charles H Roth, CENGAGE Learning.

Other useful resource(s):

1. NPTEL: https://nptel.ac.in/courses/106/105/106105185/
2. Coursera: https://www.coursera.org/learn/digital-systems
3. Swayam: https://swayam.gov.in/nd1_noc19_cs74/preview

Evaluation Scheme:

S. No.	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes(2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Switching Theory and Logic Design)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	2	2	2	2	2	x	x	x	1	3	3	2.22
CO-2	3	3	3	2	2	3	x	x	x	1	2	3	2.44
CO-3	3	3	2	3	3	2	x	x	x	1	2	3	2.44
CO-4	3	3	2	3	3	2	x	x	x	1	3	2	2.44
Average	3	2.75	2.25	2.5	2.5	2.25	x	x	x	1	2.5	2.75	

Time-Frequency Analysis and Applications

COURSE CODE: 18B1WEC738

COURSE CREDITS: 3

CORE/ELECTIVE: Elective

L-T-P: 3-0-0

Pre-requisite: Signals and Systems

Course Objectives:

1. Study and analyze various spectral analysis and time-frequency analysistools.
2. Study the time-frequency analysis tools based algorithm for different applications.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Understand the concept of the spectral analysis.	Familiarity
CO-2	Familiar with the basics concept of the short time Fourier transform /continuous wavelet transform.	Assessment
CO-3	Understand the basic concept of the distribution based Time-Frequency Analysis tools.	Assessment
CO-4	Develop the TFA based algorithms for various applications.	Usage

Course Contents:

Unit	Contents	Lectures required
1.	Introduction to spectral analysis: Parametric and Non-Parametric methods.	6
2.	Basics of Time Frequency Analysis: Basic Concepts & Definition, Duration-Bandwidth Principle, Joint Energy Density, Short-time FT, its Properties & Applications, MATLAB based implementation of STFT	6
3.	Wavelet transforms: Continuous Wavelet Transform and its Computational aspects, Scale to Frequency conversion, Scalogram, Scaling Function and Wavelets, Applications of CWT, MATLAB based implementation of wavelet transform.	8
4	Distributions based time-frequency tools: Wigner-Ville Distributions, Interference in WVD, its Applications, Cohen's class, Smoothed WVD, Ambiguity Functions, Affine Class, and MATLAB based implementation of distribution based time-frequency analysis tools.	8
5.	Case studies: Radar and Sonar, Economic Data Analysis with the Gabor Spectrogram, Gabor Spectrogram in Ultrasonic Nondestructive Materials testing, Applications of Time-Frequency Analysis in spectrum sensing, Biomedical signal processing, Genomics data analysis.	14
Total lectures		42

Suggested Text Book(s):

1. Hayes MH. Statistical digital signal processing and modeling. John Wiley & Sons; 2009.
2. Boashah B. Time-frequency signal analysis and processing: a comprehensive reference. Academic Press; 2015.

Suggested Reference Book(s):

1. S. Mallat, A Wavelet Tour of Signal Processing - The Sparse Way. Elsevier, Third Edition, 2009.
2. Cohen, Leon, Time-frequency analysis. Vol. 778. Prentice hall, 1995.
3. Chen, Victor C., and Hao Ling. Time-frequency transforms for radar imaging and signal analysis. Artech house, 2002.

Other useful resource(s):

1. http://nptel.ac.in/courses/117101001/: The lecture series on Wavelets and Multi-rate Digital Signal Processing

created by Prof. Vikram M. Gadre in NPTEL.

2. Time-frequency toolbox (MATLAB) is available for download from http://tftb.nongnu.org/
3. http://nptel.ac.in/courses/117101001/1

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Time-Frequency Analysis and its Applications)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	3	2	2	2	1	1	1	1	3	3	3	2
CO-2	2	3	3	3	3	1	1	1	2	3	3	3	2.3
CO-3	3	3	3	3	3	1	1	1	2	3	3	3	2.4
CO-4	3	3	3	3	3	3	3	3	3	3	3	3	3
Average	2.5	3	2.75	2.75	2.75	1.5	1.5	1.5	2	3	3	3	

Wavelets and Applications

COURSE CODE:

COURSE CREDITS:

CORE/ELECTIVE: ELECTIVE

L-T-P: -3-0-0

Pre-requisite: Linear Algebra, Digital Signal Processing. Course Objectives:

1. To introduce students to wavelet techniques and its types.
2. To enable students to apply wavelets in various engineering applications

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Understand the basics of wavelet transforms and compare it with Fourier transform.	Familiarity
CO-2	To construct various wavelet bases and know how to use them as a tool for analyzing functions.	Assessment
CO-3	Be familiar with multi-resolution analysis.	Familiarity
CO-4	Implement discrete wavelet transforms with multi-rate digital filters.	Assessment
CO-5	Design certain classes of wavelets to specification and justify the basis of the application of wavelet transforms to different fields.	Usage

Course Contents:

Unit	Contents	Lectures required
1	Introduction: Stationary and non-stationary signals, Signal representation using basis and frames, Brief introduction to Fourier transform and Short time Fourier transform, Time-frequency analysis, Bases of time frequency: orthogonal, Filter banks, Multi resolution formulation: Wavelets from filters, Classes of wavelets: Haar, Daubechies, bi-orthogonal.	7
2	Continuous Wavelet Transform: Continuous wavelet transform (CWT), Time and frequency resolution of the continuous wavelet transform, Construction of continuous wavelets: Spline, orthonormal, bi-orthonormal, Inverse continuous wavelet transform, Redundancy of CWT, Zoom property of the continuous wavelet transform, Filtering in continuous wavelet transform domain.	8
3	Discrete Wavelet Transform and Filter Banks: Orthogonal and biorthogonal two-channel filter banks, Design of two-channel filter banks, Tree-structured filter banks, Discrete wavelet transform, Non-linear approximation in the Wavelet domain, multi resolution analysis, Construction and Computation of the discrete wavelet transform, the redundant discrete wavelet transform	8

4	Multi Resolution Analysis: Multirate discrete time systems, Parameterization of discrete wavelets, Bi-orthogonal wavelet bases, Two dimensional, wavelet transforms and Extensions to higher dimensions, wave packets	7
5	Applications: Signal and Image compression, Detection of signal changes, analysis and classification of audio signals using CWT, Wavelet based signal de-noising and energy compaction, Wavelets in adaptive filtering, Adaptive wavelet techniques in signal acquisition, coding and lossy transmission, Digital Communication and Multicarrier Modulation, Trans multiplexers , Image fusion, Edge Detection and object isolation.	12
Total lectures		42

Suggested Text Book(s):

1. S. Mallat, "A Wavelet Tour of Signal Processing", 3rd Ed., Academic Press, Elsevier, Dec. 2008.
2. Raghuveer Rao and Ajit S. Bopardikar, "Wavelet transforms: Introduction, Theory and applications", Pearson Education Asia, 2000.

Suggested Reference Book(s):

1. J.C. Goswami and A. K. Chan, "Fundamentals of Wavelets: Theory, Algorithms, and Applications", 2nd ed., Wiley, 2011.
2. Michel Misiti, Yves Misiti, Georges Oppenheim, Jean Michel Poggi, "Wavelets and their Applications", John Wiley & Sons, 2010.

Other useful resource(s):

1. Link to NPTEL course contents: https://nptel.ac.in/courses/117/101/117101001/
2. MIT link: https://ocw.mit.edu/courses/mathematics/18-327-wavelets-filter-banks-and-applications-spring-2003/lecture-notes/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (1) - 5 Quizzes (2) - 15 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course Outcomes (Principles of Communication Systems)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	3	3	1	2	1	2	1	2	2	3	2.17
CO-2	3	3	3	3	3	2	2	2	1	1	1	3	2.25
CO-3	3	3	3	3	2	3	3	2	1	2	3	3	2.58
CO-4	3	3	3	2	2	1	1	1	1	2	3	3	2.08
CO-5	3	3	3	2	3	2	1	2	1	2	3	3	2.33
Average	3.00	3.00	3.00	2.60	2.20	2.00	1.60	1.80	1.00	1.80	2.40	3.00	

Wireless Communication and Mobile Networks

COURSE CODE:

COURSE CREDITS: 3

CORE/ELECTIVE: CORE

L-T-P: 3-0-0

Pre-requisite:

None

Course Objectives:

1. To introduce students to the basic concepts and techniques of wireless communication.
2. To become familiar with technology employed in next generation of mobile communication.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Understanding of evaluation of wireless system	Familiarity
CO-2	Acquire knowledge of cellular systems	Familiarity
CO-3	Modelling and analysis of fading channels in wireless system	Usage
CO-4	In depth knowledge of various techniques used in wireless mobile system.	Assessment
CO-5	Understanding of GSM, 4G and 5 G network	Assessment

Course Contents:

Unit	Contents	Lectures required
1.	Introduction to wireless and mobile communication: Evolution of mobile radio communication fundamentals. General model of wireless communication link, Types of Signals, Cellular Infrastructure, Cellular System Components, Antennas for Cellular Systems, Operation of Cellular Systems,	5
2.	Channel Assignment, Frequency reuse, Channel Assignment strategies, Handoff Strategies Cellular Interferences, Sectorization; Wireless Channel and Radio Communication, Free Space Propagation Model, Channel Noise and Losses, Fading in Land Mobile Systems, Multipath Fading, Fading Effects on Signal and Frequency, Shadowing.	5
3.	Wireless Channel Modeling: AWGN Channel, Rayleigh Channel, Rician Fading Channel, Nakagami Fading Channel, Ocumura and Hata Path Loss Model; Channel Modelling: Stochastic, Flat Fading, Wideband Time Dispersive Channel Modelling	8

4.	Theory of Vocoders, Types of Vocoders; Spread Spectrum Modulation, Pseudo-Noise Codes with Properties and Code Generation Mechanisms, DSSS and FHSS Systems, Time Hopping and Hybrid Spread Systems; Multicarrier Modulation Techniques. Zero Inter Symbol Interference Communication Techniques, Detection Strategies, Diversity Combining Techniques: Selection Combining, Threshold Combining, Equal Gain Combining, Maximum Ratio Combining; Spatial Diversity and Multiplexing in MIMO Systems, Channel Estimation.	9
5.	Equalization Techniques: Adaptive Equalizers, Zero Forcing Equalizers, Decision Feedback Equalizers, GSM system for mobile Telecommunication: GSM Architecture, Fundamentals of GSM Network, GSM Channels, Waveform Coding and Call Flow in GSM, Waveform Coding, GSM Vocoders, Call flow in GSM.	9
6.	Introduction to 4G, 5G and concept of NGN	6
Total lectures		42

Suggested Text Book(s):

1. T.S. Rappaport, "Wireless Communication", 2nd Edition, Prentice Hall., 2010.
2. A.Goldsmith, " Wireless communication" 1st Edition , Cambridge University Press, 2005.

Suggested Reference Book(s):

1. G. S. Rao, " Mobile Cellular Communication", Pearson Education, 2012.
2. K. Feher, "Wireless Digital Communications", PHI,1999.

Other useful resource(s):

1. Link to NPTEL course contents: Advanced 3G and 4G Wireless Mobile Communications

https://www.youtube.com/watch?v=-ymnQ5rpcYA&list=PLbMVogVj5nJSi8FUsvglRxLtN1TN9y4nx

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered up to T-1
2	T-2	25	1.5 Hours	Syllabus covered up to T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs):

CO/PO (Wireless Communication and Mobile Networks)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO1	2	3	2	2	2	2	2	1	1	2	3	3	2.08
CO2	2	3	3	2	3	2	2	1	1	2	2	3	2.16
CO3	3	2	3	3	3	3	1	2	3	3	3	3	2.66
CO4	3	3	3	3	3	3	3	1	3	3	3	2	2.75
CO5	3	3	2	3	3	3	3	1	3	3	3	3	2.75
Average	2.6	2.8	2.6	2.6	2.8	2.6	2.2	1.2	2.2	2.6	2.8	2.8	

Artificial intelligence Techniques for Genomics Signal Processing

COURSE CODE: 20B1WEC735

COURSE CREDITS: 3

CORE/ELECTIVE: Open Elective

L-T-P: 3-0-0

Pre-requisite: Engineering Mathematics, MATLAB Programming/Python Programming/R programming,

Course Objectives:

1. This course has been designed for the students of CSE/IT/ECE/BT & Bioinformatics.
2. It will provide the ability to students to extract the hidden information about the diseases and different functionalities in the living organism via the processing of the genomics data (It's a kind of Big Data) using Artificial intelligence and signal processing.
3. In this course basic introduction of genomics, numerical representation of the DNA sequences, preprocessing/de-noising and feature techniques, and applications of machine learning, deep learning and transfer learning will be discussed.
4. With completion of the course students may find the opportunities in the companies, which are working on the genomics data or Bioinformatics.

Course Outcomes:

Course Outcomes ()		**Level of Attainment**
CO-1	Student will be familiar with the genomics signal processing	Familiarity
CO-2	Student will able to understand the pre-processing and de-noising techniques	Assessment
CO-3	Student will able to understand the artificial neural network along with its training and testing.	Assessment
CO-4	Student will able to understand the deep learning techniques along with its implementation.	Assessment
CO-5	Student will able to apply the artificial intelligence techniques in genomics signal processing.	Usage

Course Contents:

S. No.	**Contents**	**Contact Hours**
1	**Genomics signal processing** Basics of genomics, genomics signal processing, Numerical mapping schemes for the DNA sequences. Hands on practice using MATLAB/Python/R	06
2	**Feature extraction techniques and de-noising techniques** DFT, DWT, CWT, STFT, WVD, and other spectral methods. Hands on practice using MATLAB/Python/R	08

3	**Artificial neural network** Introduction to supervised, unsupervised, reinforcement learning, learning rule, and activation functions, artificial neural networks. Training of ANN in MATLAB/Python/R	08
4	**Deep learning methods** Convolution neural network, LSTM, pre-trained networks and other networks, Hands on practice using MATLAB/Python/R	08
5.	**Applications of artificial intelligence techniques in genomics signal processing.** Hands on practice of artificial intelligence techniques in genomics signal processing applications using MATLAB programming/Python programming/R-programming.	12
	Total	**42**

Suggested Text Book/Study Material(s):

1. Dougherty ER, Shmulevich I, editors. **Genomic signal processing and statistics.**Hindawi Publishing Corporation; 2005.
2. Data Analytics in Bioinformatics: A Machine Learning Perspective. 2021.
3. Yu N, Li Z, Yu Z. "Survey on encoding schemes for genomic data representation and feature learning—from signal processing to machine learning", Big Data Mining and Analytics. 2018.
4. Min, Seonwoo, Byunghan Lee, and Sungroh Yoon. "Deep learning in bioinformatics." Briefings in bioinformatics 18, no. 5,2017.
5. Dias R, Torkamani A. **Artificial intelligence in clinical and genomic diagnostics**. Genome medicine. 2019.
6. Latest research paper from reputed journals

Suggested Reference Book(s):

1. Advanced Machine Learning and Signal Processing, is part of the IBM Advanced Data Science Specialization

   https://www.coursera.org/learn/advanced-machine-learning-signal-processing#syllabus
2. Machine learning for signal processing

   http://home.iitk.ac.in/~vipular/stuff/2019_MLSP.html
3. Deep learning for signal processing

   https://www.kdnuggets.com/2020/07/deep-learning-signal-processing.html
4. Rahman, M. Z. U., &Putluri, S. (2021). *Genomic Sequence Analysis for Exon Prediction Using Adaptive Signal Processing Algorithms*. CRC Press.
5. Shmulevich, I. and Dougherty, E.R., 2010. *Probabilistic Boolean networks: the modeling and control of gene regulatory networks*. Society for Industrial and Applied Mathematics.
6. Aparna G, Mary GA, Sumana G. Performance Analysis of Signal Processing Techniques in Bioinformatics for Medical Applications Using Machine Learning Concepts.
7. Shmulevich I, Dougherty ER. **Genomic signal processing**. Princeton University Press; 2014 Sep 8.
8. Rahman, M. Z. U., &Putluri, S. "Genomic Sequence Analysis for Exon Prediction Using Adaptive Signal Processing Algorithms". CRC Press.2021
9. Randhawa, G., Hill, K. & Kari, L. ML-DSP: Machine Learning with Digital Signal Processing for ultrafast, accurate, and scalable genome classification at all taxonomic levels. BMC Genomics, 2019
10. Introduction to genomic signal processing with control. CRC Press; 2018

11. Morales JA, Saldaña R, Santana-Castolo MH, Torres-Cerna CE, Borrayo E, Mendizabal-Ruiz AP, Vélez-Pérez HA, Mendizabal-Ruiz G. Deep Learning for the Classification of Genomic Signals. Mathematical Problems in Engineering. 2020

Other useful resource(s):

1. Genomic Signal Processing and Data Science
   http://users.ece.utexas.edu/~hvikalo/ee381v.html
2. Genomics Signal Processing
   https://alterlab.org/teaching/BME6770/Syllabus.pdf

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered up to T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes(2) -10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

COs/POs	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	2	2	2	3	3	2	3	3	3	3	2.666667
CO-2	3	3	3	3	3	3	3	3	3	3	3	3	3
CO-3	3	3	3	3	3	2	3	3	2	3	3	3	2.833333
CO-4	3	3	3	3	3	3	2	3	3	3	3	3	2.916667
Average	3	3	2.75	2.75	2.75	2.75	2.75	2.75	2.75	3	3	3	

Automation and Robotics

COURSE CODE: 20B1WEC731

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Prerequisite: None

Course Objectives:

1. To develop the student's knowledge in various robot structures and their workspace.
2. To use the robotic system for logic building & programming and to solve many engineering problems.

Course Outcomes:

Sl. No.	Course Outcomes	Level of Attainment
1	Learn about brief history, types, requirement and architecture of automation, and their applications	Familiarity
2	Learn about PLC, DCS and SCADA, and their applications	Assessment
2	Learn basic principles of robotics, its configurations, kinematics, dynamics, motion planning and control	Assessment
3	Acquire knowledge about the principles of various sensors, actuators and their applications in robots.	Assessment
4	Understand the concept of dynamics and control for a typical pick and place robot.	Usage

Course Contents:

Unit	Contents	Lectures required
1	Introduction: History of automation, Automation systems, types of automation, Automation overview, Requirement of automation systems, Architecture of Industrial Automation system, Advantages and limitations of Automation, Industrial revolutions.	6
2	Automation components: Sensors and actuators, Electric, Hydraulic, Pneumatic, actuators, process control valves, Introduction of DC and AC servo drives for motion control. Controllers, Transmitters and Signal Conditioning: Need of transmitters, Standardization of signals, Current, Voltage and Pneumatic signal standards, 2-Wire & 3-Wire transmitters, Analog and Digital signal conditioning for sensors, Smart and Intelligent transmitters	8
3	PLC, SCADA & Distributed control system: Elements of SCADA, Features of SCADA, MTU, RTU Functions, Applications of SCADA, Communications in SCADA, Introduction to DCS, Architecture, Input and output modules, Specifications of DCS	6

4	Introduction to Robotics: Definition of robot, types of robots, classification and usage, Terminology of robotics, Specifications of robot, Architecture of robotic systems, Robot Sensors and Machine Vision System: Internal and external sensors: position, velocity and acceleration sensors, proximity sensors, force sensors, laser range finder; Robot vision: image processing fundamentals for robotic applications	8
5	Robot Arm Kinematics and Dynamics:Position and orientation of a rigid body, Homogeneous transformations, Forward kinematics, Inverse kinematics, Lagrange formulation of dynamics	6
6	Motion Planning and Control: Joint and Cartesian space trajectory planning and generation, Classical control concepts using the example of control of a single link and two-link manipulators, Independent joint PD and PID control, Control of a multi-link manipulator	6
Total lectures		42

Suggested Text Book(s):

1. J. J. Craig, “Introduction to Robotics- Mechanics and Control”, Pearson,3rd Edition, 2009.
2. Spong and Vidyasagar, “Robot Dynamics and Control”, Wiley Student Edition, John Wiley and Sons, 2013.
3. Madhuchhanda Mitra, SamarjitSen Gupta, “Programmable Logic controllers and Industrial Automation”, Penram International, 2008
4. C.D. Johnson, “Process Control Instrumentation Technology”, 8th Ed., PHI, 2015

Suggested Reference Book(s):

1. Sciavicco and Siciliano, “Modeling and Control of Robot Manipulators”, Springer, 2nd Edition, 2002.
2. D.K. Pratihar, “Fundamentals of Robotics”, Narosa Publishing House, 1st Edition, 2017.
3. AshitavaGhoshal, “Robotics-Fundamental Concepts and Analysis”, Oxford University Press, 6thImpression, 2010. 8.
4. R. K. Mittal and I. J. Nagrath, “Robotics and Control”, Tata McGraw Hill, New Delhi, 4th Reprint, 2005.
5. Gregory K. McMillan, P. Hunter Vegas, “Process / Industrial Instruments and Controls Handbook,” 6th Ed., McGraw Hill, 2019
6. Bela G. Liptak, KrisztaVenczel, “Instrument and Automation Engineers' Handbook: Process Measurement and Analysis,” 5th Ed., CRC Press, 2016

Other useful resource(s):

1. Link to NPTEL course contents:https://nptel.ac.in/courses/112101099/
2. Other links to course material: https://nptel.ac.in/downloads/112101098/
3. Material provided by IIT Bombay under eLSI project: http://elsi.e-yantra.org/resources

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered up to T-1
2	T-2	25	1.5 Hours	Syllabus covered up to T-2
3	T-3	35	2 Hours	Entire Syllabus

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4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Automation and Robotics)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	2	2	1	1	2	2	2	**1.8**
CO-2	3	3	3	2	3	2	2	1	1	2	3	3	**2.3**
CO-3	3	3	3	3	3	3	3	1	2	3	3	3	**2.8**
CO-4	3	3	3	3	3	3	3	1	2	3	3	3	**2.8**
CO-5	3	3	3	3	3	3	3	1	2	3	3	3	**2.8**
Average	**2.8**	**2.8**	**2.8**	**2.6**	**2.8**	**2.6**	**2.6**	**1**	**1.6**	**2.6**	**2.8**	**2.8**	

AVR Based Embedded System Design

COURSE CODE: 20B1WEC534
COURSE CREDITS: 2
CORE/ELECTIVE: ELECTIVE
L-T-P: 2-0-0

Pre-requisite: **C/C++ Programing.**

Course Objectives:

1. To develop an understanding of the AVR processors, instruction sets and addressing modes.
2. To develop the student's knowledge in various robot structures and their workspace.
3. To use the robotic system for logic building & programming and to solve many engineering problems.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Students will be equipped with the automation and brief history of robots and their applications.	Familiarity
CO-2	Students will be able to learn basic principles of robotic technology, configurations, control and programming of robots.	Assessment
CO-3	Students will be equipped with the principles of various sensors, actuators and their applications in robots.	Assessment
CO-4	Students will be able to understand the concept of dynamics and control for a typical pick and place robot.	Usage

Course Contents:

Unit	Contents	Lectures required
1	**AVR Microcontrollers:** Microcontrollers and Embedded Processors, Overview of AVR family, Pin diagram, Block Diagram, AVR Microcontroller architecture, Status registers, General purpose registers, Data Registers, Memory organization, PWM, ADC, EEPROM, Instruction set, I/O ports, Interrupt, On-Chip peripherals, Timer, Counter.	6
2	**Embedded C:** Introduction, Decimal, binary and HEX numbers in C language, Basic elements in C, Variable types, variable declaration, Operators, Decision making, Loops, Functions, Arrays, Pointers, Structurer. C pre-processor.	5
3	**AVR Programming:** AVR studio setup, AVR compiler, AVR data types, Addressing modes of AVR, DDRx, PORTx, PINx registers, AVR I/O Port Programming, Time delay loop, Look-up table, Bit addressability, HEX file configuration of I/O registers, Timer programming, Input capture and Wave Generator, PWM programming External Interrupt programming, ADC programming, EEPROM programming.	5
4	**Serial Communication:** USART, I2C, I2C bus protocol, TWI in AVR, I2C programming in AVR using C, SPI Protocol, SPI bus protocol, SPI programming in AVR, RF Module, RF Communication, GSM Module, GSMAT Command, AT Command, Interfacing of GSM Module with Microcontroller, Xbee Module, Xbee Communication, Configure Xbee module, Xbee Communication Between PC & Micrcontroller, Implement of Xbee Based	6

	Application.	
5	**Peripheral Interfacing:** Interfacing with Display devices, LED, LCD, Seven Segment Display, Interfacing Motors with Microcontroller, Interfacing Sensors, Interfacing programs.	**6**
Total lectures		**28**

Suggested Text books:

1. Steven F. Barrett, Steven Frank Barrett, "Embedded Systems Design with the Atmel AVR Microcontroller", Morgan & Claypool Publishers, 2009.
2. Muhammad Ali Mazidi, Sarmad Naimi and Sepehr Naimi, "The AVR Microcontroller and Embedded Systems Using Assembly and C", 1st Ed., PHI, 2010.
3. Dhananjay Gadre,, "Programming and Customizing the AVR Microcontroller", McGraw Hill Education, 2017.

Suggested Reference books:

1. Steven F. Barrett, Daniel J. Pack "Atmel AVR Microcontroller Primer: Programming and Interfacing" Morgan & Claypool Publishers, 2008.
2. D.K. Pratihar, "Fundamentals of Robotics", Narosa Publishing House, 1st Edition, 2017.

Weblink:

1. https://nptel.ac.in/courses/108/105/108105102/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (3) - 10 Quizzes (3) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (AVR Based Embedded System Design)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	2	2	2	2	1	1	1	2	3	3	**2.08**
CO-2	3	3	3	2	3	2	1	1	1	1	2	3	**2.08**
CO-3	3	3	3	3	3	3	2	1	3	2	2	3	**2.58**
CO-4	3	3	3	3	3	3	2	1	3	2	3	3	**2.27**
Average	**3.00**	**3.00**	**2.75**	**2.50**	**2.75**	**2.50**	**1.50**	**1.00**	**2.00**	**1.75**	**2.50**	**3.00**	

AVR Based Embedded System Design Lab

COURSE CODE: 20B1WEC571

COURSE CREDITS: 1

CORE/ELECTIVE: ELECTIVE

L-T-P: 0-0-2

Pre-requisite: **Introduction to programming, Digital Electronics Lab**

Course Objectives:

1. To teach and help students acquire new skills in an era of rapidly evolving technology in the field of robotics.
2. To create the next generation of embedded systems engineers with a practical outlook to help provide practical solutions to some of the real world problems.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO1	Identify different components of embedded systems and robotics using Firebird-V robotic research platform.	Familiarity
CO2	To develop embedded C/C++ programs in different embedded systems programming platforms and gain practical exposure to interface various IO devices with Firebird-V robot.	Assessment
CO3	To acquire hands-on learning and experience through appropriate Sensors and Machine vision system for a real-time operation.	Assessment
CO4	Develop an AVR microcontroller based robotic system, using embedded C language programming concepts for handling a real life task.	Usage

List of Experiments:

S.No	Description	Hours
1	Introduction to Firebird-V Robotics Research Platform. • Firebird V AVR Platform • Major Components of a Robot: Sensors, Actuators, Control, Power, Communication, Display etc. • AVR Programming Tools: ATMEL STUDIO 6	2
2	Basic IO Interfacing on Firebird-V • Input-Output Ports in ATmega2560 and associated registers • Buzzer Interfacing	2
3	Motion Control of Firebird-V Robot • Forward, backward, left and right motion • Direction control of DC motor	2
4	DC Motor Velocity Control Using Pulse Width Modulation (PWM) • Pulse width modulation, Duty cycle • Timer in AVR and their associated registers	2

	• PWM generation in Firebird-V	
5	Servo Motor Control Using Pulse Width Modulation (PWM) • Pulse width modulation, Duty cycle • Timer in AVR and their associated registers • PWM generation in Firebird-V	2
6	LCD Interfacing on Firebird V Robot • Understanding LCD and its initialization • Displaying text at different positions on the LCD and implementing a simple scrolling display.	2
7	Interrupts handling on Firebird-V Robot • Closed-loop programming • Sources of Interrupt on ATmega2560 • Interrupt handling programming	2
8	To perform Analog to Digital conversion (ADC) on Firebird-V Robot • Need for ADC, ADC of ATmega2560 • Coding ADC	2
9	To perform white line following on Firebird-V Robot • Principle of line following sensor • Location of line following sensor in firebird-V • Program to follow white line	2
10	PC Based Control Using Serial Communication on Firebird-V Robot • Robot control using RS232 serial port • Robot control using XBee wireless communication module	2
Total Lab hours		**20**

Suggested/Resources:

1. Steven F. Barrett, Steven Frank Barrett, "Embedded Systems Design with the Atmel AVR Microcontroller", Morgan & Claypool Publishers, 2009.
2. Dhananjay Gadre,, "Programming and Customizing the AVR Microcontroller", McGraw Hill Education, 2017.
3. Steven F. Barrett, Daniel J. Pack "Atmel AVR Microcontroller Primer: Programming and Interfacing" Morgan & Claypool Publishers, 2008.
4. Resource provided by e-Yantra link here: http://elsi.e-yantra.org/resources
5. Resource provided by Firebird VAtmega2560 link here: http://www.nexrobotics.com/robots.html

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Attendance	15 Marks
4	Lab Assessment	45 Marks
	Total	100 marks

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Average
CO1	3	3	3	3	2	2	1	2	3	2	1	3	**2.33**
CO2	3	3	3	3	1	1	1	1	1	1	1	2	**1.75**
CO3	3	3	3	3	2	1	1	1	2	2	1	3	**2.08**
CO4	2	3	1	3	2	1	1	1	1	1	1	3	**1.67**
Average	**2.75**	**3.00**	**2.50**	**3.00**	**1.75**	**1.25**	**1.00**	**1.25**	**1.75**	**1.50**	**1.00**	**2.75**	

Bioinformatics MBII Lab COURSE CODE: 18MS7BI214 L-T-P: 0-0-2 Credits: 1	**Course Objectives** The objectives of this course are to provide practical experience of the use of common computational tools and databases which facilitate investigation of molecular biology and evolution-related concepts.	**Students Learning outcomes** **Students should be able** ▪ Understand the use of common bioinformatics resources (NCBI) ▪ Understand various databases and tools in NCBI (PubMed, Nucleotide, gene, proteins, BLAST) ▪ Understand various databases and tools in Expasy (Swissprot, PROSITE) ▪ Hands-on of pairwise sequence alignment tools-global and local ▪ Hands-on of multiple sequence alignment tools ▪ Developing three-dimensional model of a protein structure ▪ Hands-on of phylogenetic analysis tools and visualization

Syllabus:

1. Retrieval of literature and biological sequences from PubMed and NCBI.
2. BLAST program for comparing primary biological sequence information.
3. Protein resources: Use of ExPASy for sequence retrieval and analysis.
4. Use of EMBOSS tools for sequence analysis: Pairwise Sequence Alignment.
5. Use of Clustal and other tools (MAFFT, MUSCLE) for Multiple Sequence Alignment (MSA).
6. Use of PDB structural database and structure visualization using Pymol, Rasmol, and Discovery Studio.
7. Use of gene prediction methods (GRAIL, Genscan, Glimmer).
8. Phylogenetic analysis of protein and nucleotide sequences.
9. Secondary structure prediction using protein sequence.
10. Use of different protein structure prediction databases (SCOP & CATH).
11. Homology modelling of proteins in MODELLER.
12. Use of various primer designing and restriction site prediction tools.
13. Prediction of RNA secondary structure.
14. Use of tools for mutation and analysis of the energy minimization of protein structures.

Recommended Textbooks and References:

Text Books:

1. D.W. Mount *Bioinformatics: Genome and Sequence Analysis*: (2001) Cold Spring Harbor Laboratory Press, Cold Spring Harbor, New York.
2. Ian Korf, Mark & Josaph: *BLAST*, Oreilly Publisher, 2003
3. R. Durbin, S. Eddy, A. Krogh and G. Mitchison, *Biological Sequence Analysis: Probabilistic Models of Proteins and Nucleic Acids.* Cambridge University Press.
4. J. Pevsner (2002) Bioinformatics and Functional Genomics; Cold Spring Harbor Laboratory Press, Cold Spring Harbor, New York.
5. A.D. Baxevanis & B.F.F. Oulette *Bioinformatics – A practical guide to the Analysis of Genes and Proteins*,2002, Willey International publishers.
6. M.J. Bishop and C.J. Rawlings (editors), *DNA and Protein Sequence Analysis---A Practical Approach* IRL Press at Oxford University Press, ISBN 0 19 963464 7 (Pbk)
7. Lesk, A. M. (2002). *Introduction to Bioinformatics*. Oxford: Oxford University Press.
8. J. Pevsner (2002) Bioinformatics and Functional Genomics; Cold Spring Harbor Laboratory Press, Cold Spring Harbor, New York.

Recombinant DNA Technology Lab COURSE CODE: 18MS7BT373 L-T-P: 0-0-4 Credits: 2	**Course Objectives** The objectives of this course are to provide students with experimental knowledge and hands-on skills of methods and techniques for recombinant DNA technology and molecular cloning.	**Students Learning outcomes** Students should be able to gain hands-on experience in recombinant DNA technology techniques of gene cloning, protein expression. This experience would enable them to begin a career in industry that engages in genetic engineering as well as in research laboratories conducting fundamental research.

Syllabus:

1. Preparation of stock buffers (TBE, TAE, TE) and Agarose gel electrophoresis
2. Plasmid DNA isolation and DNA quantitation
3. Extraction of DNA from gel
4. In vitro amplification of DNA fragment by Polymerase Chain Reaction
5. Designing of Primers and PCR cycle for given DNA sequence and analysis by Gradient PCR
6. Restriction Enzyme digestion of plasmid DNA (Blunt & Cohesive)
7. Vector and Insert Ligation (Using T_4 DNA ligase)
8. Preparation of competent cells by $CaCl_2$ treatment
9. Transformation of *E. coli* with standard plasmids, Calculation of transformation efficiency
10. Electroporation of plasmid DNA into mycobacterial cells
11. Confirmation of the insert by Colony PCR and Restriction mapping
12. Expression of recombinant protein, concept of soluble proteins and inclusion body formation in *E. coli*
13. SDS-PAGE analysis of proteins
14. Plating of Bacteriophage

Recommended Textbooks and References:

1. Green, M. R., & Sambrook, J. (2012). *Molecular Cloning: A Laboratory Manual.* Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.

Basics of Mathematics and Statistics **COURSE CODE: 20MS1MA111** **L-T-P: 2-0-0** Credits 2	**Course objective** The objective of this course is to give conceptual exposure of essential contents of mathematics and statistics to students for application in biological sciences	**Students Learning Outcomes** On completion of this course, students should be able to: ▪ Gain broad understanding in mathematics and statistics; ▪ Recognize importance and value of mathematical and statistical thinking, training, and approach to problem solving, on a diverse variety of disciplines.

Unit I Algebra 8 lectures	Linear equations, functions: slopes-intercepts, forms of two-variable linear equations; constructing linear models in biological systems; quadratic equations (solving, graphing, features of, interpreting quadratic models *etc*.), introduction to polynomials, graphs of binomials and polynomials; Symmetry of polynomial functions, basics of trigonometric functions, Pythagorean theory, graphing and constructing sinusoidal functions, imaginary numbers, complex numbers, adding-subtracting-multiplying complex numbers, basics of vectors, introduction to matrices.
Unit II Calculus 6 lectures	Differential calculus (limits, derivatives), integral calculus (integrals, sequences and series *etc*.).
Unit III Mathematical models in biology 6 lectures	Population dynamics; oscillations, circadian rhythms, developmental patterns, symmetry in biological systems, fractal geometries, size-limits & scaling in biology, modelling chemical reaction networks and metabolic networks.
Unit IV Statistics 8 lectures	Probability: counting, conditional probability, discrete and continuous random variables; Error propagation; Populations and samples, expectation, parametric tests of statistical significance, nonparametric hypothesis tests, linear regression, correlation & causality, analysis of variance, factorial experiment design.

Recommended Textbooks and References:

1. Stroud, K. A., & Booth, D. J. (2009). *Foundation Mathematics*. New York, NY: Palgrave Macmillan.
2. Aitken, M., Broadhursts, B., & Haldky, S. (2009) *Mathematics for Biological Scientists*. Garland Science.
3. Billingsley, P. (1986). *Probability and Measure.* New York: Wiley.
4. Rosner, B. (2000). *Fundamentals of Biostatistics*. Boston, MA: Duxbury Press.
5. Daniel, W. W. (1987). *Biostatistics, a Foundation for Analysis in the Health Sciences*. New York: Wiley.

Biochemistry **COURSE CODE: 20MS1BT111** **L-T-P: 3-0-0** Credits 3	**Course objective** Following are the objectives of Biochemistry course. ▪ To understand the basic biochemical processes and their principles those govern complex biological systems. ▪ To understand the structure, functions of essential biomolecules and their interactions with each other. ▪ To understand the various metabolic and energy generation processes which are essential for sustainability of life.	**Students Learning outcomes** After learning and completion of Biochemistry course, student will be able to: ▪ Define the structural features of basic biomolecules ▪ Describe the functionality of biomolecules in relation to their usage for steady state of an organism. ▪ Get complete understanding of metabolic processes and their integration with each other.

Unit/ Module	Description
Unit I: Origin of Life (Biochemical basis) 4 lectures	Chemical basis of life: Miller-Urey experiment, abiotic formation of amino acid oligomers, composition of living matter; Water and its essential role for life, pH and its regulation in relation to microorganisms
Unit II: Biomolecules in Microbial world 8 lectures	**Carbohydrates:** Classification, basic chemical structures and their role in microbial life. **Lipids:** Classification, structure and function of major lipid subclasses in microbe's especial consideration bacterial membranes. **Proteins:** Amino acids: Classification, Properties, Protein Structure: primary, secondary, tertiary and quaternary structure, basics of enzymes and their catalysis. **Nucleotides:** Nucleotides, Nucleosides structures, Different confirmations of DNA
Unit III: Microbial nutrition and basic biochemical process for growth 4 lectures	Microbial metabolic diversity and classification based on nutritional types. Transport Mechanisms across membrane: Diffusion, facilitated Diffusion, Active and passive transport.
Unit IV: Central Metabolic Pathways and Carbohydrate metabolism 10 lectures	Bacterial aerobic respiration, Embden-Meyerhof pathway, Entner-Doudoroff pathway, Pentose phosphate pathway, Tricarboxylic acid cycle, components of electron transport chain, chemiosmotic theory, oxidative and substrate level phosphorylation, , Utilization of sugars other than glucose and complex polysaccharides. Bacterial anaerobic respiration and fermentation
Unit IV: Metabolism of lipids and hydrocarbons: 6 lectures	Biosynthesis and degradation of fatty acids and phospholipids, lipopolysaccharide biosynthesis
Unit V: Protein and amino-acid metabolism 6 lectures	Metabolism of amino acids: Amino acid biosynthesis and utilization, lysine and glutamine overproduction, polyamine biosynthesis and regulation.
Unit VI: Metabolism of nucleotides 4 lectures	Purine and pyrimidine biosynthesis, regulation of purine and pyrimidine biosynthesis, inhibitors of nucleotide synthesis.

Recommended Textbooks and References:

1. J M Berg, L Stryer, J Tymoczko, G Gatto, “Biochemistry”, 9th Ed., (2019) W H Freeman
2. D L Nelson and MM Cox, “Lehninger Principles of Biochemistry”, 7th Ed. (2017) WH Freeman
3. J Willey, L Sherwood, C J Woolverton “Prescott's Microbiology”, 10th Ed., (2016) Mc GRaW-Hill

Computer Applications in Environmental Engineering

COURSE CODE:

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P:1-0-4

Pre-requisite: Environmental Engineering and Software lab in Civil engineering

Course Objectives:

1. Physical Characteristics of waste water Sample.
2. Inorganic Constituents of waste water Sample
3. Biological Characteristics of wastewater Sample.
4. Jar Test.
5. Judge the suitability of water for drinking purposes.

✓ **Water and wastewater**

- MATLAB
- Statistica, Berkeley Madonna
- Microsoft Excel type of software could be used for mathematical modeling, statistical analysis, solving differential equations, etc.
- Sewer GEMS
- Modeflow
- Hydromantics-GPS-X
- WatPro-Predicting Water modelling
- SIMBA

✓ **Environment Assessment and Decision Making**

- SimaPro/ Gabi- Life Cycle Assessment/ Carbon foot printings
- openLCA

✓ **Environmental data, measuring, monitoring and planning**:

- ArcMap 10: Geographical Information System (GIS) software.
- qGIS : Open-source GIS software
- LEAM : Land use evolution and Impact assessment model

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO1	Identify environmental problems arising due to engineering and technological activities and the science behind those problems.	Familiarity
CO2	Determination of various inorganic impurities in wastewater.	Assessment

CO3	Determine physical, chemical and biological characteristics of water and wastewater.	Assessment
CO4	Analyze material balance for different environmental systems.	Usage
CO5	Assess the quality of water and wastewater	Usage

Course Contents:

S.No	Description	Hours
1	Understanding of MATLAB software and its usability	2
2	Application and working of Statistica, Berkeley Madonna and its use with the experiments value.	2
3	Analysis of sewer Gem for determination of wastewater parameters	2
4	Detailed working, application and usability of Mode flow and Hydromantics-GPS-X in regard of water samples.	2
5	Detailed working, application and usability of WatPro-Predicting Water modelling and SIMBA	2
6	Analysis of data using SimaPro or Open LCA	2
7	Analysis and application of ArcMap 10: Geographical Information System (GIS) software, qGIS : Open-source GIS software and LEAM : Land use evolution and Impact assessment model	2
		14

List of Experiments:

S.No	Description	Hours
1	Determination of pH and Temperature of water and wastewater sample.	2
2	Determination of total solids, suspended solids and dissolved solids of water and wastewater sample.	2
3	Determination of specific conductivity of water and wastewater sample.	2
4	Determination of turbidity.	2
5	Determination of chlorides of water and wastewater sample.	2
6	Determination of type and extent of alkalinity of water and wastewater sample.	2
7	Determination of type and extent of acidity of water and wastewater sample.	2

8	Determination of temporary and permanent hardness.	**2**
9	Determination of optimum dose of coagulant.	**2**
10	Determination of Sulphates of water and wastewater sample.	**2**
11	Determination of Kjeldahl Nitrogen (Inorganic) of the sample.	**2**
12	Determination of dissolved oxygen.	**2**
13	Determination of Biological oxygen demand (BOD).	**2**
14	Determination of Chemical oxygen demand (COD).	**2**
Total Lab hours		**28**

Suggested/Resources:

1. Standard methods for the examination of water and wastewater. (2012). 21st Edition, Washington:APHA.
2. Sawyer, C. N., McCarty, P. L., and Perkin, G.F., Chemistry for Environmental Engineering andScience, 5th edition McGraw-Hill Inc.,2002
3. Kotaiah, B., and Kumara Swamy, N., Environmental Engineering Laboratory Manual, CharotarPublishing House Pvt. Ltd., 1st Ed., 2007
4. Mathur, R.P., Water and Wastewater testing: A laboratory Manual(2013).

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem.Evaluation	20 Marks
3	Attendance	15 Marks
4	Lab Assessment	45 Marks
	Total	100 marks

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course Outcomes (Environmental Engineering Lab)	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**Average**
CO-1	3	3	3	3	2	2	1	1	1	1	1	1	**1.83**
CO-2	3	3	3	3	3	1	1	1	1	1	1	3	**2.00**
CO-3	3	3	2	3	2	3	2	1	1	1	2	1	**2.00**
CO-4	3	3	3	2	3	2	1	1	1	1	1	1	**1.83**
Average	**2**	**2**	**3**	**3**	**3**	**3**	**1**	**1**	**1**	**1**	**1**	**1**	**1.83**

Digital Image Processing using Python

COURSE CODE: 21B1WEC731

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Python

Course Objectives:

1. To introduce various fundamentals of Digital Image Processing.
2. To provide hands-on practice on different image processing methods using python.

Course Outcomes:

Sl. No.	Course Outcomes	Level of Attainment
CO-1	Able to understand the process of image acquisition.	Familiarity
CO-2	Able to implement different image processing methods for enhancement, edge detection and segmentation.	Assessment
CO-3	Able to implement different image processing methods on python	Usage
CO-4	Understand the concept of machine learning in images.	Familiarity

Course Contents:

Unit	Contents	Lectures required
1	**Introduction to Image Processing:**- Acquisition of Images, Image Sampling and quantization, Intensity and Spatial Resolution of Images.	**7**
2	**Introduction to Python and OpenCV:** Introduction to Numpy, Pandas, and OpenCV. Implementation of basic functions like reading & writing an image, cropping, resizing, rotation of images.	**7**
3	**Image enhancement:** Histogram and contrast on an image, point processing of an image, processing in spatial domain, processing in spectral domain, noise modeling. Implementation of enhancement methods using python.	8

4	**Edge Detection:** Point detection, line detection, different gradient operators, Laplacian operator, and Canny edge detection. Implementation of edge detection using python.	8
5	**Image Segmentation:** Intensity thresholding based image segmentation; Region growing and region splitting algorithm; watershed segmentation. Implementation of segmentation methods using python.	**7**
6	**Machine Learning based Image Processing:** Introduction to Machine Learning and convolutional neural network.	**5**
Total lectures		**42**

Suggested Text Book(s):

1. RC Gonzalez, RE Woods, Digital Image Processing, 3rd Ed., Pearson Publisher, 2008.
2. Ravishankar chityala, Sridevi Pudipeddi, Image Processing and Acquisition using Python, 2nd Ed., CRC Press, 2020.

Suggested Reference Book(s):

1. Chris Solomon, Toby Breckon: Fundamental of Digital Image Processing, 1st Ed., John Wiley & Sons, 2011.
2. Jan Erik Solem, Programming Computer Vision with Python: Tools and Algorithms for Analyzing Images, O'Reilly Media, 2012

Other useful resource(s):

1. https://nptel.ac.in/courses/108/103/108103174/ (Prof. M.K. Bhuyan, Electrical Engineering, IIT Guwahati)
2. https://docs.opencv.org/4.x/d9/df8/tutorial_root.html

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered up to T-1
2	T-2	25	1.5 Hours	Syllabus covered up to T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Avg.
CO1	3	3	2	2	2	2	3	1	2	3	3	1	2.2
CO2	3	1	3	2	1	2	3	2	2	3	2	2	2.1
CO3	3	3	2	2	1	2	2	2	3	2	1	2	2.1
CO4	3	2	2	2	2	2	2	2	2	2	2	1	2.0
Avg.	3	2.2	2.2	2	1.5	2.0	2.5	1.7	2.2	2.5	2.0	1.5	

Digital Systems

COURSE CODE: 20B1WEC734
COURSE CREDITS: 3
CORE/ELECTIVE: ELECTIVE
L-T-P: 3-0-0

Pre-requisite: Digital Electronics

Course Objectives:

1. Design digital circuits based on the required application.
2. Design of complex digital circuits and implement them for real time applications.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	To review the basic concepts of digital systems	Familiarity
CO-2	Understand the working of sequential circuits	Assessment
CO-3	Usage of different techniques for digital systems	Usage
CO-4	Study of different hazards and races countered by digital system	Usage

Course Contents:

Unit	Contents	Lectures required
1	Review of Digital Fundamentals: Digital fundamentals, minimization and design of combinational circuits, sequential machine fundamentals, Flip flops, sequential machine operations.	9
2	Sequential circuits-I: The finite state model (FSM), Components of FSM, Memory elements, Synthesis of synchronous sequential circuits, Serial binary adder, The Sequence detector using Mealy and Moore type models, Design of a parity-bit generator and n-bit gray code counter using state diagram concept.	9
3	Sequential circuits-II: Finite state machine – Basic definition, capabilities and limitation of finite state machines, mathematical representation of synchronous sequential machine, state equivalence & machine minimization, simplification of incompletely specified machines.	9
4	Asynchronous Sequential circuits: Introduction to asynchronous circuits, Timing diagram, State diagram & flow tables, Types of asynchronous circuits, ASM charts and their usage.	9
5	Hazards in Digital Circuits: Different types of hazards and races in digital circuits and the methods to eliminate those hazards, Introduction to usage of VHDL for digital systems.	8
Total Lectures		44

Suggested Text Book(s):

1. W. I. Fletcher: An Engineering approach to Digital Design, Pearson Education, 2015.
2. M. Morris Mano & M. D. Ciletti: Digital Design: With an introduction to the Verilog HDL, VHDL, and System Verilog, 6thedition, Pearson Education, 2018
3. Fundamentals of Digital Circuits: A. Anand Kumar, 3rd edition, PHI, 2015.

Suggested Reference Book(s):

1. Charles H. Roth: Digital System Design using VHDL, 3rd edition, CENGAGE Learning, 2018.
2. ZVI Kohavi: Switching and Finite Automata Theory, 2nd edition, Tata Mcgraw Hill, 2017.

Other Useful Resource(s):

Link to NPTEL course contents: 1. https://nptel.ac.in/courses/117105080/
2. https://nptel.ac.in/courses/117106086/ (Prof. S. Srinivasan, IIT Chennai)

Approved in Academic Council held on 25.10.2018

Evaluation Scheme:

S. NO.	Exam	Marks	Duration	Coverage/Scope of Examination
1	T-1	15	1 Hour	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire semester	Assignment (2) – 10 Quizzes (2) – 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Digital Systems)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	2
CO-1	2	3	3	3	3	1	1	1	2	2	1	2	2.1
CO-1	2	2	2	2	3	1	1	1	2	2	1	2	2.1
CO-1	2	3	3	3	2	1	1	1	2	3	2	2	2.5
Average	2	2.5	2.5	2.5	2.5	1	1	1	2	2.25	1.5	2	

English

Subject Code: 21B11HS111

Course Goal

This course is aimed to equip students of engineering with effective oral and written communication. The course develops the verbal skills of the students with emphasis on learning grammatical concepts and syntactical strategies. The course emphasis is on grooming the students and their personality by focusing on written and spoken English and Communication.

Course Objectives

- The Student will be able to analyze communication situations and audiences to make choices about the most effective and efficient way to communicate and deliver messages
- The student will learn to deliver effective presentations in contexts that may require power point, extemporaneous or impromptu oral presentations
- The student will learn to write grammatically correct business documents using appropriate business style.
- The student will learn to speak and write grammatically correct sentences with the ability to express thoughts with clarity and accuracy.
- Students will develop command over their language and synchronize their thoughts into written form

Detailed Syllabi

Lecture-wise Breakup

Subject Code	**21B11HS111**	**Semester**	1
Subject Name	English		
Credits	02	**Contact Hours**	28

Faculty (Names)	**Coordinator(s)**	Dr. Papiya Lahiri

	Teacher(s) (Alphabetically)	Dr. Papiya Lahiri Dr. Tanu Sharma

Module No.	**Subtitle of the Module**	**Topics**	**No. of Lectures**
1	Concept and Nature of Communication	What is communication? Stages of communication Ideation, encoding, transmission, decoding & response Channels of communication Communication in organizational settings Etiquettes in social and Office settings Work culture in Jobs Barriers to effective communication Guidelines to overcome communication barriers	4
2	Self Development and Assessment	Self Assessment, Awareness,. Personal goal Setting **Self study**	2
3	Effective presentation	Pre- presentation jitters Preparation and practice Delivering the presentation Qualities of a skilful presenter Capturing and maintaining attention Handling questions Power point presentations	4
4	Nature and Mechanics of Writing(Basic Writing Skills)	Techniques for writing precisely: Defining Describing Classifying Use of Phrases and Clauses in sentences Importance of Proper Punctuation Organizing Principles of Paragraphs in documents	5

5	Technical Writing	Importance, structure and drafting and revising of Technical Reports Technical writing style and Language Business writing: Letters, Preparing resume, notices, agenda and minutes of meeting , Daily Dairy entry	6
6	Vocabulary Development	Word Formation Derivatives: Prefixes & Suffixes Root words Synonyms, Antonyms Homophones and Homonyms One word substitution	2
7	Grammar and Usage	Subject-Verb Agreement Noun-Pronoun Agreement Prepositions, Articles	3
8	Identifying Common errors in writing	Redundancies, Clichés , Misplace modifiers, words often confused and misused	2
Total number of Lectures			28

Methodology

The course will follow an interactive teaching-learning method with classroom discussions and activities on fundamental concepts of grammar with a strong emphasis on skill development of students with regard to speaking, writing, logically interpreting ideas into words and reasoning in the classroom. Both lab and tutorial activities are run on student –teacher individual and group interactions.

Evaluation

Sr. No.	**Components**	**Total Marks**
1	**Test 1**	15
2	**Test 2**	25
3	**Test 3**	35
4	**Internal Assessment**** **(**Class assignments **)**	25

	Total	100

Internal assessment

5 Marks	Etiquettes in Social and Office Settings
8 Marks	Self-Development and Assessment
12 Marks	Report Writing

Recommended Reading (Books/Journals/Reports/Websites etc.: Author(s), Title, Edition, Publisher, Year of Publication etc. in IEEE format)	
1.	*Practical English Usage. Michael Swan. OUP.1995.*
2.	*Remedial English Grammar. F.T. Wood. Macmillan. 2007*
3.	*On Writing Well. William Zinsser. Harper Resource Book. 2001.*
5.	*Study Writing. Liz Hamp-Lyons and Ben Heasly. Cambridge University Press. 2006*
6.	*Communication Skills. Sanjay Kumar and Pushp Lata. OUP. 2011.*
7.	*Exercises in Spoken English. Parts. I-III. CIEFL, Hyderabad. OUP*
8.	*A Communicative Grammar of English. 3rd Edn. G. Leech and J. Svartvik. 2012*
9.	*Williams, K., Krizan, A. C., Logan, J. & Merrier, P. (2011) Business Communicating in Business 8th Ed. New Delhi: Cengage Learning.*
10.	*Murphy, Herta A., Herbert Hildebrandt, Jane Thomas (2008) Effective Business Communication 7th Ed. New Delhi:Tata Mcgraw Hill Education Private Limited.*
11.	*Guffey, M. A. (2000) Business Communication: Product & Process South-Western College Publishing.*
12.	*Lesikar, R. V., Flatley, M.E., Rentz, K. & Pande, N. (2009) Business communication 11th Ed. New Delhi: Mc Graw Hill.*
13.	*Nesfield, J.C. English Grammar Series: Book IV: Idiom, Grammar and Synthesis. Macmillan, 1956.*

English Lab

COURSE CODE: 21B17HS171

COURSE CREDITS: 1

CORE/ELECTIVE: CORE

L-T-P: 0-0-2

Pre-requisite: None

Course Objectives:

1. The students will learn to speak and write grammatically correct sentences with the ability to express thoughts with clarity and accuracy.
2. The students will learn the rules of grammar in writing. It will enhance their ability to use logical sequencing while writing any business letter or document.
3. The students will learn using new words and build their vocabulary steadily and systematically by following the exercises.
4. Students will develop command over their language and synchronize their thoughts while writing different types and kinds of Business letters.
5. Students will be groomed to develop the art of speaking logically, confidently and pragmatically which involves understanding work ethics and manners and the correct use of body language.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO1	Understand and sharpen writing skills using correct grammar in Emails, Business letters and Report writing.	Usage and Assessment
CO2	Learn the basics of successful job applications.	Usage and Assessment
CO3	Help make communication stronger by learning Non verbal cues and correct Body Language.	Familiarity and Assessment
CO4	Enable students to prepare better Power Point Presentations with clarity of expression and appropriate language.	Familiarity and Assessment

CO5	Develop advanced vocabulary by learning to use different ways of word construction and strategies of learning new words.	Usage and Assessment
CO6	Learn about the ethics of writing and different types of formats in documents with command over language.	Usage and Assessment

List of Exercises

Subject Code	21B17HS171	**Semester**	1
Subject Name	English Lab		
Credits	01	**Contact Hours**	14

Faculty (Names)	**Coordinator(s)**	1. Dr. Papiya Lahiri
	Teacher(s) (Alphabetically)	1. Dr. Papiya Lahiri 2. Dr. Neena Jindal

Lab Exercise No.	Subtitle of the Module	Topics	Hours
1.	**Essays: For and Against** **Software: Practical Writing**	What will I learn? Stages of writing Brainstorming (1) Brainstorming (2) Planning your essay (1) Choosing a style Quick quiz: the Writing Process	1
2.	**Job Applications: Your Online Profile** **Software: Practical**	What will I learn? Your online profile: overview	1

	Writing	What does a profile look like The structure of a profile Proofreading: grammar Spell checking Writing focus: punctuation marks Practise proofreading Quick quiz: your personal profile	
3.	**Official Letters** **Software: Practical Writing**	What will I learn in this unit? Official letters: layout Official letters: vocabulary Build up an official letter Letters: style The cover letter: job applications Letters: proofreading Present perfect or simple past? Quick quiz: letters	1
4.	**Emails: Asking for Information (I)** **Software: Practical Writing**	What will I learn? Emails: an overview Emails: structure Finding functional language (study sheet) Asking people to do things Enquiries and Responses	1
5.	**Emails: Asking for Information (II)** **Software: Practical Writing**	Functional language for emails Emails: Correcting mistakes Write two emails (on PC note pad) Vocab Focus	1

		Quick quiz: Email basics	
6.	**Use of Body Language**	This exercise will include showing a couple of videos to the students on the use of Body Language in communication and also how to interpret other people's body language when they communicate. This will include studying facial expressions, gestures, non- verbal cues and eye contact.	1
7.	**A Short Report: Graphs (I)** **Software: Practical Writing**	What will I learn in this unit? A report on graph Choosing tenses (1) Choosing tenses (2) Write a report (1) [on PC note pad] Prepositions of time (1) Describing differences (1) Quick quiz: A report on graphs	1
8.	**A Short Report: Hotel and restaurants (II)** **Software: Practical Writing**	What will I learn? Restaurant reviews: structure Vocab: Hotels and restaurants Topic sentences (1) Mixing sentences (1) Mixing sentences (2) Past or Present? Write two reviews (Any one of the two on PC note pad) Quick quiz: a short report	1
9.	**Use of Power point presentation**	This exercise will comprise of two videos on the specifics of preparing power- point presentations; the Do's and don'ts; examples from	1

		successful business entrepreneurs' presentations.	
10.	**Vocabulary Development**	Synonyms, Antonyms, Standard Abbreviations One word Substitution Homophones, Homonyms, Paronyms, Words often confused and misused Word Functioning Idiomatically Foreign Words Prefixes Suffixes (5 each on PC note pad)	1
11.	**Reported Speech** **Software :Tense Buster**	Introduction The Rule Practice: Pronouns Practice: Verbal Actions Pronunciation: Stress and Rhythm Do you understand? Vocab: Reporting verb Your test	1
12.	**Essays: Descriptive** **Software: Practical Writing**	What will I learn? Planning your essay (1) Planning your essay (2) Words and senses (1) Vocab focus: choosing precise words Linking ideas (1) Linking ideas (2) Quick quiz: descriptive essays	1

13.	**Avoiding Plagiarism Ist part** **Software: Practical Writing** **Taking Notes IInd part** **Software: Practical Writing**	What will I learn? Plagiarism: an overview Identify plagiarism Past or present? Quick quiz: plagiarism <u>Taking notes</u> What will I learn? Taking notes: the main points Taking notes: the layout Taking notes: abbreviations Quick quiz: taking notes	1
14.	**Text speak** **Software: Practical Writing**	What will I learn? Text speak: an overview Text terms (1) Text terms (2) Inviting people to do things Responding appropriately Text speak and speaking Quick quiz: text speak	1
		Total	14

Methodology

The course follows a lab based teaching-learning method with classroom discussions and activities on fundamental concepts of grammar with a strong emphasis on skill development of students with regard to speaking, writing, logically interpreting ideas into words and reasoning in the classroom. The exercises are solved by the students on the software's and the marking is automatically shown. Additionally, they are asked to draft letters and memos in their Lab files/registers after reading specimens on the software's and improve their English with choice of specific and technical words.

Evaluation

Sr. No.	Components	Total Marks
1	Proforma/Assignments	10
2	Mid Term	20
3	End term	20
4	Tutorial Activities	50
	Total	100

SOFTWARE DETAIL

There are presently three softwares running in the Language Lab. These are as follows:

1. Software Clarity S. Net 7

This software supports Wireless LAN and wired LAN.

Main Functions

1. Screen Broadcast: Teacher PC can broadcast the screen, video file, flash smoothly without delay to student PC.
2. Voice Broadcast: Teacher can broadcast his voice without delay to student PC.
3. Screen Recorder: Teacher and student can record their own operations and then save in video file, which can be broadcast in any PC which has installed media player
4. Monitor: Teacher can monitor any student PC in the classroom.
5. Media Player. Teacher can broadcast all kinds media file formats, such as MPEG, DAT, MVI and so on, to student PC without delay.
6. Control Website and application: Teacher can restrict student to visit any website or application freely.
7. Teacher can remote open website on student PC.
8. Group Teaching: Teacher can divide the students into several groups, and set leader for each group to run group teaching.
9. Exam: It has strong exam functions. Teacher can know student study progress from students by using this function easily.
10. Remote Command: Teacher can remote run the program in student PC; teacher can remote start-up, turn off and restart student computer.
11. File transfer and collect the file: Teacher can transfer the file to student PC easily, and also teacher can collect the file from student PC.
12. Restrict USB: Teacher can restrict student to use USB flash memory freely. 13. Digital Recorder: It can record teacher and student voice, which can be used in language lab.

Requirements

Teacher side Requirements: CPU Core 2 E6300, 2Gbytes Memory, 256Mbytes Display Card

Student side Requirements: CPU Core 2 E4300, 1Gbytes Memory, 128Mbytes Display Card

Operating System: Support all Windows, includes Windows 8.1,8, 7, Vista, XP and so on. Network: Wired Network 10MB/100MB/1000MB. Wireless Network 802.11n.

Overview:

Clarity English publishes programs, aimed at specific language areas in English like Grammar, Reading, Study Skills & Results Tracking. Under 'Clarity English', there are three softwares in our language lab which are Tense Buster, Practical Writing and Clear Pronunciation. The Program named Tense Buster focuses on 33 areas of Grammar through reading, listening, speaking & writing. It is one of a kind which is accepted by British Council in all its 226 teaching centres.

2. **Software: Tense Buster 9.0 (3 years)**

Licence Details

Tense Buster V11
Licence type: Anonymous Access

Version: International English
Number of concurrent users: 33
Start date: 2021-08-09
Expiry date: 2025-08-08

Tense Buster is an ESL (English as a second language) program which focuses on helping students improve their reading, writing, listening, speaking, vocabulary and grammar skills in 5 levels (beginner, upper intermediate, intermediate, lower intermediate, advanced).

Tense Buster covers 33 aspects of the English language through presentations, practice exercises, rules, tests and learner training tips. Students learn how to ask questions, make comparisons, and report on what they've heard, in addition to learning how to describe past, present and future events.

Each unit begins with a presentation of a grammar topic based on a dialogue, a newspaper article, a radio broadcast or an extract from a story, where learners are encouraged to form theories about how the grammar works. Next comes checking questions focusing on key areas of difficulty, and a grammar rule. Students move on to practice and testing activities in which the language is contextualized and key aspects of form and function are highlighted. Each unit includes a video-based pronunciation activity relating to an aspect of the grammar. Finally, each unit includes a vocabulary session and ends by suggesting extension activities. All activities include detailed feedback.

Multimedia Authoring Kit

This kit enables the teacher to create effective exercises tailored to students' specific needs. The Tense Buster multimedia Authoring Kit comprises a wide range of exercise types. It lets you add your own material and adapt the courses to the needs of your students. Use any one of

these formats to create your own activities: drag and drop, proof reading and free practice as well as target spotting, multiple choice questions, true/false, text and gap fill.

3. Software: Practical Writing

Licence Details (3 years)

Practical Writing V11
Licence type: Anonymous Access

Version: International English
Number of concurrent users: 33
Start date: 2021-08-09
Expiry date: 2025-08-08

This cloud based software helps in developing the writing skills of the students. It has 10 core skill development areas:

1. Essays: For and Against
2. Job Applications: your online profile
3. Emails: Asking for Information
4. A Short Report: Graphs
5. A Short Report: Hotels and Restaurants
6. Avoiding Plagiarism
7. Taking Notes
8. Essays: Descriptive
9. Textspeak
10. Official Letters

Each area deals with a separate set of exercises that are designed to master the skill set of LSRW. It entails learning about reports, cover letters, resumes, drafting business letters, textspeak, spell check etc. It covers a wide range of topics on grammar, functional language, formal and communicative language. The Lab exercises will be covered from Tense Buster and Practical Writing software.

Every week the students perform the exercises and enter their auto-system-generated scores on the printed pro forma.

4. Software: Clear Pronunciation 2 V11

License Details (1 year)

Clear Pronunciation 2 V11
Licence type: Anonymous Access

Version: British English
Number of concurrent users: 33
Start date: 2021-08-09
Expiry date: 2022-08-08

This software is particularly for learning and practicing phonetics or the study of the sounds of human speech. It deals with five distinct areas:

- Consonant Clusters
- Word Stress
- Connected Speech
- Sentence stress
- Intonation

All these areas will make the students practice correct pronunciation and listen to their own recorded voices and make improvement.

I[st] SEMESTER (MBI)

GENERAL MICROBIOLOGY AND BACTERIOLOGY COURSE CODE: 21MS1MB111 L-T-P: 3-0-0 Credits: 3	**Course Objectives** To acquaint the students with the development and techniques of microbiology useful in biotechnology industry. Scientific evaluation of various characteristics of icroorganisms, especially bacteria their metabolism and role in various domains of life.	**Students Learning outcomes** Students should be able to: ▪ Acquire the principles of Microbiology and fundamental concepts related to microbial classification and methods ▪ Scientifically test the hypothesis provided under a given situation involving microbial world and demonstrate practical skills in basic microbiological techniques including growth and control of bacteria. ▪ Analyze and interpret the experiments/pathways relevant to bacterial analysis ▪ Designate vital role of the bacteria in the environment and their genetics and association with human beings. ▪ Retrieve and use cotemporary information and industrial potential related to microbial world.

Syllabus:

Unit	Topics Covered
Unit 1: Introduction, history and scope of Microbiology 4 lectures	Introduction, history and scope of Microbiology. General characteristics and composition of Prokaryotes and Eukaryotes. Classification of Microorganisms: Haeckel's three kingdom concept, Whittaker's five kingdom concept, three domain concept of Carl Woese, classification and salient features of bacteria according to Berger's Manual of Determinative Bacteriology. Nomenclature and modern methods of Bacterial taxonomy.
Unit 2: Morphology and Anatomy of bacteria 6 lectures	Morphology and ultra-structure of bacteria: size, shape, and arrangement of bacteria, ultra-structure of bacterial cell wall of eubacteria and archeabacteria. Protoplast and spheroplast formation and L-form. Components external to cell wall: Structure and function of flagella, fimbriae and pilli, capsule- types, composition and function, slime layers, S-layers. Prokaryotic cell membrane and cytoplasmic matrix – cell membrane structure and function of bacteria and archaebacteria, mesosomes, ribosomes, cytoplasmic inclusion bodies (polyhydroxy butyrate, polyphosphate granules, oil droplets, cyanophycean granules) and nucleoid. Bacterial response to external stimulus and bacterial endospores: Chemotaxis and phototaxis structure, formation and germination of bacterial

	endospore.
Unit 3: Analytic techniques and control measures in bacteriology 7 lectures	Staining methods: fixation, types of dyes, simple staining, differential staining - Gram and Acid-fast staining, staining of specific structures capsule, flagella and spore staining Control of microorganisms: Microbial death curve, concept of bio-burden, thermal death time and decimal reduction time. Factors influencing the effectiveness of antimicrobial agents. Control of bacteria by physical agents: heat - moist and dry, filtration and radiation. Chemical control of microorganisms: Halogens, phenol and other phenolic compounds, heavy metals, alcohols, ethylene oxide and aldehydes
Unit 4: Bacterial growth and kinetics 7 lectures	Bacterial nutrition: Basic nutritional requirements, growth factors, nutritional categories, physical requirements of bacterial growth. Bacteriological media: types (complex, synthetic, differential, enrichment and selective media) and their uses, culture characteristics of bacteria on different media. Cultivation of bacteria: aerobic and anaerobic culture, pure culture techniques, shaker and still culture, maintenance and preservation of microbial culture. Bacterial growth: growth kinetics, growth curve. Batch, continuous and synchronous culture. Measurement of growth and influence of environmental factors affecting growth.
Unit 5: Bacterial reproduction and genetics 7 lectures	General concept of Prokaryotic and Eukaryotic genome. Genome of *E. coli.* Genetic recombination and transformation. Transduction: generalized and specialized transduction, phage conversion. Plasmid: types and their significance. Conjugation and chromosomal mobilization. *E. coli* as model prokaryotes.
Unit 6: Bacterial epidemiology and diseases 5 lectures	Human diseases caused by bacteria; The epidemiology, pathogenesis, antigenic characteristics and diagnosis of diseases
Unit 7: Microbial Ecology and Industrial applications 6 lectures	Thermophiles, Alkaliphiles, Acidophiles, Halophiles, Psychrophiles, Radiophiles, Fermented foods and beverages, Biofertilizers, Biopesticides, Biofuels and Bioenergy

Recommended Textbooks and References:

1. Prescott, Harley and Klein: Microbiology, 6th Edition, McGraw Hill 2005.
2. Pelczar, Chan and Krieg: Microbiology by; Tata McGraw Hill.
3. Madigan, M.T., Martinko, J.M., Parker, J: Brock Biology of Microorganisms. 10th Edition.: Publisher: Prentice Hall 2003
4. Gerard J. Tortura, Berdell R. Funke, and Christine L: Microbiology An Introduction: Case. 8th Ed., Pearson/Benjamin Cummings, 2004.
5. Nester: Microbiology Study Guide McGraw Hill.
6. Black: Microbiology: Principles and Applications Prentice Hall

Image Sensing and Reconstruction

COURSE CODE: 20B1WEC736

COURSE CREDITS: 3

CORE/ELECTIVE: OPEN ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Prerequisites are good programming skills, basic theory of signals and systems, signal processing and some university level mathematics.

Course Objectives:

1. To understand the basic concepts of image formation, filtering and reconstruction.
2. To study various mathematical algorithms that allow usto process and manipulate 2D image data.
3. To discuss the issues and challenges pertaining to real timeimaging.
4. To study and analyze various states - of - the - art imageenhancement algorithms.
5. Study of application domains: industrial and scientific imaging.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Analyze the need and foundation of digital image sensing and reconstruction	Familiarity
CO-2	Study of the mathematical algorithms for filtering the image data	Assessment
CO-3	Analysis of problemsand approaches in real time image processing.	Assessment
CO-4	Study of application domains.	Usage

Course Contents:

Unit	Contents	Lectures required
1	**Fundamentals of Image Sensing:** Accessing Image Data, Image Types, Conceptualizing Images, Human Visual System, Simplified Imaging Model, Image Sampling and Quantization. CCD and CMOS Sensors.	8
2	**Image Transformations:**Gray Level Transformations, Image Histogram and Processing, Multispectral Transformations, Multi – Image Transformations, Image Interpolation and Warping.	8
3	**Spatial Domain Filtering:** Point Processing, Neighborhood Processing, 2D Convolution, Image Smoothing, Computation of First Derivative and Second Derivative, Non – Linear Filters, Gray Scale Morphological Operators.	7
4	**Frequency Domain Filtering:** Fourier Transform and Discrete Fourier Transform (DFT), Two Dimensional DFT, Low Pass filtering, High Pass Filtering, Band Pass Filtering, Homomorphic Filtering, Short Time	7

	Fourier Transform, Discrete Wavelet Transform.	
5	**Image Segmentation and Compression Techniques:** Edge Detection, Local and Global Thresholding, Adaptive Thresholding, Geometrical Processing, Watershed Algorithm, Basic Image Compression, Lossless and Lossy Compression, Image Compression Models.	**6**
6	**Applications of Image Sensing and Reconstruction:** Image Detection, Recognition and Verification, CNN for Image Recognition, Pattern Recognition and Motional Tracking, Real Time Imaging.	**6**
Total lectures		**42**

Suggested Text Book(s):

1. R. C. Gonzalez and R. E. Woods, Digital Image Processing,Third Edition, Pearson Prentice Hall, 2008
2. Stan Birchfield, Image Processing and Analysis, CengageLearning India Private Limited, 2018

Suggested Reference Book(s):

1. D. K. Theckadath, Digital Image Processing using MATLABCoding, Third Edition, Tech - Max Publications, 2010.
2. A. K. Jain, Fundamentals of Digital Image Processing, Prentice – Hall, 1989.

Other useful resource(s):

Link to topics related tocourse:

i. https://nptel.ac.in/courses/digital image processing
ii. www.tutorialspoint.com/digital image processing

EvaluationScheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes(2) -10 Attendance - 5

Course Outcomes (COs) contribution to the ProgrammeOutcomes(POs)

Course outcomes (Image Sensing and Reconstruction)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average

CO-1	2	2	3	3	2	1	1	1	2	2	2	2	**2**
CO-2	2	3	3	3	2	1	1	1	2	2	1	2	**2**
CO-3	2	3	3	3	2	1	1	1	2	2	1	2	**2**
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	**2**
Average	**2**	**3**	**3**	**3**	**2**	**1**	**1**	**1**	**2**	**2**	**3**	**2**	

LIFE SKILLS AND EFFECTIVE COMMUNICATION

COURSE CODE:

COURSE CREDITS:1

CORE/ELECTIVE: CORE
L-T-P: 1-0-0

Pre-requisite: None

Course Objectives:

1. Define their life and career goals.
2. Learn Self-Motivation and leadership skills
3. Analyze and Know EQand CQ levels and utilize them in team building
4. Develop communication (speaking and writing) and Listening skills
5. Develop creativity and critical thinking

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Know your Perception and Attitude	Familiarity
CO-2	Access your Motivation levels and Leadership skills	Assessment
CO-3	Assess Emotional Intelligence	Assessment
CO-4	Develop effective communication and listening skills	Usage
CO-5	Enhance critical thinking	Usage

Subject Code		**Semester**	2
Subject Name	Life Skill and Effective Communication		
Credits	01	**Contact Hours**	14
Course Coordinator	Dr Tanu Sharma		

Course Contents:

Sr No	Content	Lectures required
Module 1	**Life Skills**	
1	Understanding The Self / Individual- Ability, Perception, Attitude, Personality(Big five model)	1
2	Self-Motivation and Goal Setting- Concept of Motivation, Key Elements, Theory of Motivation, Goal setting Theory	1
3	Time Management- Importance of time management, time management matrix, dealing with procrastination	1
4	Being Emotionally Intelligent- What is Emotional Intelligence, Dimensions of EI, Models of EI, EI in workplace, Improve your EI	1
5	Assertive Communication and Persuasions skills Define Assertiveness, The art of persuasion, From persuasion to negotiation	1
6	Group Dynamics- Group Process Components, Characteristics of a Group, Group Performance, Ethical and legal considerations related to group work	1
7	Leadership and Team Management- Define leadership, Leadership Styles, Developing Leadership, Defining Teams, Types of Team, Team Processes, Decision making in a team	2
8	Creative and Critical Thinking Defining and measuring creativity, models of creativity, creativity at the workplace, creativity enhancing activities, creativity-critical thinking- problem solving	1
Module 2	**Effective Communication**	
9	Interpersonal Barriers in Communication and how to effectively overcome them	1
10	Studying and understanding Non-Verbal communication – Kinesis, Paralanguage, Haptics, , interpreting nonverbal cues	1
11	Active Listening – A trait of a good leader	1
12	Technical writing - technical details into well structured documents, Writing ,Correspondence and Job descriptions	2
Total lectures		**14**

Methodology

The course follows a teaching-learning method with classroom discussions and activities on fundamental concepts on skill development of students with regard to speaking, listening and, logically interpreting ideas into words and reasoning in the classroom.

Suggested Text Book(s):

1. Stephen P. Robbins ,Organizational Behavior
2. Anthony Baker, Time Management. Managing Your Time Effectively
3. Daniel Goleman,Emotional Intelligence: Why It Can Matter More Than IQ
4. Kenneth H. Blanchard , Spencer Johnson,The One Minute manage
5. Ed Catmull, Amy Wallace, Creativity, Inc.: Overcoming the Unseen Forces That Stand in the Way of True Inspiration

Suggested Reference Book(s):

1. working with Emotional Intelligence, Daniel Goleman
2. Orgaqnizational Behaviour, K. Aswathappa
3. Organisational Behaviour An Introduction, Christine Cross Ronan Carbery

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire	5 marks attendance
			Semester	10 – case study –report on Time management
				10- case study-Herd Behaviour and the Housing Bubble (and Collapse)

Attainment of POs through Cos												
Sr No	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12
CO-1	1	1	1	1	1	1	1	1	1	1	1	1
CO-2	0	0	0	0	0	0	0	0	0	0	0	0
CO-3	1	1	1	1	1	1	1	1	1	1	1	1
CO-4	1	1	1	1	1	1	1	1	1	1	1	1
CO-5	1	1	1	1	1	1	1	1	1	1	1	1
Average Score	.83	.83	.83	.83	.83	.83	.83	.83	.83	.83	.83	.83

LIFE SKILLS AND EFFECTIVE COMMUNICATION LAB

COURSE CODE:

COURSE CREDITS:1

CORE/ELECTIVE: CORE
L-T-P: 0-0-2
Pre-requisite: None

Course Objectives:

1. Develop attitude and self awareness
2. Learn Self-Motivation and leadership skills
3. Develop communication (writing and speaking) and Listening skills
4. Develop Emotional intelligence and team woeking ability
5. Develop creativity and critical thinking

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Know your Perception and Attitude	Familiarity
CO-2	Access your Motivation levels and Leadership skills	Assessment
CO-3	Assess EQ and Team work	Assessment
CO-4	Develop effective communication and listening skills	Usage
CO-5	Enhance critical thinking	Usage

Subject Code		**Semester**	2
Subject Name	Life Skill and Effective Communication lab		
Credits	01	**Contact Hours**	28
Course Coordinator	Dr Tanu Sharma		

Course Content

GD Activities	Topc	Activities =language lab and GD	Hours	Evaluation
1	Self-awareness	a)MBI- Personality Test ---Measure, Assessment, Discussion b)Video on Personality Development --- Discussion and Reporting	2	5
2	Being Emotionally Intelligent	Emotional Intelligent Test --- Measure, Assessment, Discussion Talk by Daniel Goleman https://youtu.be/0yGNhCaKJKk https://youtu.be/FKjj1tNcbtM ---- Discussion and Reporting	2	5
3	Group Dynamics	Group activity – Desert Island	2	
4	Leadership and Team Management	Team Building Activities/ Case study / Role play on leadership https://wikispaces.psu.edu/display/PSYCH484/Goal+Setting+Case+Study Discussion, analysis, and assessment	2	5
5	Creative and Critical Thinking	Creativity Quotient – Measure and Discussion a)The Research Response Exercise- Take the following argument:-*Pesticides harm the environment more than they're worth.* b) Make An "Argument Map" Read about how leaders face and resolve challenges- Report submission	2	5
6	Effective Communication	a)Advanced Phrasal verbs b)Advanced Past perfect \ **Software: Tense Buster**	2	
7	Non –Verbal Communication	Role Play on Body Language How to kill your body language Frankenstein (Run time: 16:36 mins) - Discussion, analysis, Role Play, Reporting	2	5
8	Listening skills	a)A Case for Active Listening Jason Chare at TED Tokyo teachers (Run time 15:24 mins.) Discussion, Analysis and reporting		5

		b) https://agendaweb.org/listening/audio-activities-5.html Audio activity – Notting Hill Scene 1		
9	Etiquettes and Manners	https://youtu.be/LR1TroBTlwA, https://youtu.be/svzTEUxs3A8 Discussion and reporting		5
10	Persuasive Communication	a) Shashi Tharoor (Run time:19:22 mins.) Discussion , analysis and reporting b) https://www.skillsconverged.com/FreeTrainingMaterials/tabid/258/articleType/CategoryView/categoryId/140/Persuasion-Skills.aspx		
11	Group vise activities : Groups made according to diagnostic Test -	**Group 1 – and Group 2** a) Intermediate - The Passive b)Intermediate- Question Tags Software: Tense Buster **Group 3 and Group 4** a)Speaking Exercise -GD / brainstorming	1 1 2	
12	Group vise activities : Groups made according to diagnostic Test	**Group 1 – and Group 2** a)Intermediate Equality Case study b) Intermediate Relative Clauses Software: Tense Buster **Group 3 and Group 4** Case study on Team building	1 1 2	
13	Group vise activities : Groups made according to diagnostic Test	Group 1, Group2, Group3, Group4 a)Team work and Group Activities where Group 4 Members take the leadership/ Mentor Roles b) Technical writing Exercises Notices Correspondences – Email writing and Letter writing Job Description Social Media Profiles	1 1	10
14	Group vise activities : Groups made according to diagnostic Test	Group 1, Group2, Group3, Group4 Presentations	2	15
		Total	28	60

Methodology

The course follows a lab-based teaching-learning method with classroom discussions and activities on fundamental concepts of grammar with a strong emphasis on skill development of students with regard to speaking, writing, logically interpreting ideas into words and reasoning in the classroom. The exercises are solved by the students on the software and the marking is automatically shown.

Suggested Reference Books and Readings

1. https://www.hugheseducation.com/blogs/5-leadership-lessons-from-business-tycoon-ratan-tata

2.Leading the team you always wanted by Casey Paul D

3.The Making of a Manager: What to Do When Everyone Looks to You By Julie Zhuo

4. Think and grow Rich by Napoleon Hill

5. Deliver the right message in conversations, emails, and presentations by Stephanie Overby

6. Unleash the Power of Storytelling: Win Hearts, Change Minds, Get Results By Rob Biesenbach

7. Five Stars: The Communication Secrets to Get from Good to Great By Carmine Gallo

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	P-1	20	1 Hour.	Syllabus covered upto T2
2	P-2	20	1.5 Hours	Syllabus covered upto T-3
4	P-3 Teaching Assessment	60	Entire Semester	Based on lab and Gd activities

Attainment of POs through Cos												
Sr No	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12
CO-1	1	1	1	1	1	1	1	1	1	1	1	1
CO-2	0	0	0	0	0	0	0	0	0	0	0	0
CO-3	1	1	1	1	1	1	1	1	1	1	1	1
CO-4	1	1	1	1	1	1	1	1	1	1	1	1
CO-5	1	1	1	1	1	1	1	1	1	1	1	1
Average Score	.83	.83	.83	.83	.83	.83	.83	.83	.83	.83	.83	.83

I[st] SEMESTER (MBI)

GENERAL MICROBIOLOGY AND BACTERIOLOGY COURSE CODE: 21MS1MB111 L-T-P: 3-0-0 Credits: 3	**Course Objectives** To acquaint the students with the development and techniques of microbiology useful in biotechnology industry. Scientific evaluation of various characteristics of icroorganisms, especially bacteria their metabolism and role in various domains of life.	**Students Learning outcomes** Students should be able to: ▪ Acquire the principles of Microbiology and fundamental concepts related to microbial classification and methods ▪ Scientifically test the hypothesis provided under a given situation involving microbial world and demonstrate practical skills in basic microbiological techniques including growth and control of bacteria. ▪ Analyze and interpret the experiments/pathways relevant to bacterial analysis ▪ Designate vital role of the bacteria in the environment and their genetics and association with human beings. ▪ Retrieve and use cotemporary information and industrial potential related to microbial world.

Syllabus:

Unit	Topics Covered
Unit 1: Introduction, history and scope of Microbiology 4 lectures	Introduction, history and scope of Microbiology. General characteristics and composition of Prokaryotes and Eukaryotes. Classification of Microorganisms: Haeckel's three kingdom concept, Whittaker's five kingdom concept, three domain concept of Carl Woese, classification and salient features of bacteria according to Berger's Manual of Determinative Bacteriology. Nomenclature and modern methods of Bacterial taxonomy.
Unit 2: Morphology and Anatomy of bacteria 6 lectures	Morphology and ultra-structure of bacteria: size, shape, and arrangement of bacteria, ultra-structure of bacterial cell wall of eubacteria and archeabacteria. Protoplast and spheroplast formation and L-form. Components external to cell wall: Structure and function of flagella, fimbriae and pilli, capsule- types, composition and function, slime layers, S-layers. Prokaryotic cell membrane and cytoplasmic matrix – cell membrane structure and function of bacteria and archaebacteria, mesosomes, ribosomes, cytoplasmic inclusion bodies (polyhydroxy butyrate, polyphosphate granules, oil droplets, cyanophycean granules) and nucleoid. Bacterial response to external stimulus and bacterial endospores: Chemotaxis and phototaxis structure, formation and germination of bacterial

	endospore.
Unit 3: Analytic techniques and control measures in bacteriology 7 lectures	Staining methods: fixation, types of dyes, simple staining, differential staining - Gram and Acid-fast staining, staining of specific structures capsule, flagella and spore staining Control of microorganisms: Microbial death curve, concept of bio-burden, thermal death time and decimal reduction time. Factors influencing the effectiveness of antimicrobial agents. Control of bacteria by physical agents: heat - moist and dry, filtration and radiation. Chemical control of microorganisms: Halogens, phenol and other phenolic compounds, heavy metals, alcohols, ethylene oxide and aldehydes
Unit 4: Bacterial growth and kinetics 7 lectures	Bacterial nutrition: Basic nutritional requirements, growth factors, nutritional categories, physical requirements of bacterial growth. Bacteriological media: types (complex, synthetic, differential, enrichment and selective media) and their uses, culture characteristics of bacteria on different media. Cultivation of bacteria: aerobic and anaerobic culture, pure culture techniques, shaker and still culture, maintenance and preservation of microbial culture. Bacterial growth: growth kinetics, growth curve. Batch, continuous and synchronous culture. Measurement of growth and influence of environmental factors affecting growth.
Unit 5: Bacterial reproduction and genetics 7 lectures	General concept of Prokaryotic and Eukaryotic genome. Genome of *E. coli.* Genetic recombination and transformation. Transduction: generalized and specialized transduction, phage conversion. Plasmid: types and their significance. Conjugation and chromosomal mobilization. *E. coli* as model prokaryotes.
Unit 6: Bacterial epidemiology and diseases 5 lectures	Human diseases caused by bacteria; The epidemiology, pathogenesis, antigenic characteristics and diagnosis of diseases
Unit 7: Microbial Ecology and Industrial applications 6 lectures	Thermophiles, Alkaliphiles, Acidophiles, Halophiles, Psychrophiles, Radiophiles, Fermented foods and beverages, Biofertilizers, Biopesticides, Biofuels and Bioenergy

Recommended Textbooks and References:

1. Prescott, Harley and Klein: Microbiology, 6th Edition, McGraw Hill 2005.
2. Pelczar, Chan and Krieg: Microbiology by; Tata McGraw Hill.
3. Madigan, M.T., Martinko, J.M., Parker, J: Brock Biology of Microorganisms. 10th Edition.: Publisher: Prentice Hall 2003
4. Gerard J. Tortura, Berdell R. Funke, and Christine L: Microbiology An Introduction: Case. 8th Ed., Pearson/Benjamin Cummings, 2004.
5. Nester: Microbiology Study Guide McGraw Hill.
6. Black: Microbiology: Principles and Applications Prentice Hall

Basics of Mathematics and Statistics **COURSE CODE: 20MS1MA111** **L-T-P: 2-0-0** Credits 2	**Course objective** The objective of this course is to give conceptual exposure of essential contents of mathematics and statistics to students for application in biological sciences	**Students Learning Outcomes** On completion of this course, students should be able to: ▪ Gain broad understanding in mathematics and statistics; ▪ Recognize importance and value of mathematical and statistical thinking, training, and approach to problem solving, on a diverse variety of disciplines.

Unit I Algebra 8 lectures	Linear equations, functions: slopes-intercepts, forms of two-variable linear equations; constructing linear models in biological systems; quadratic equations (solving, graphing, features of, interpreting quadratic models *etc*.), introduction to polynomials, graphs of binomials and polynomials; Symmetry of polynomial functions, basics of trigonometric functions, Pythagorean theory, graphing and constructing sinusoidal functions, imaginary numbers, complex numbers, adding-subtracting-multiplying complex numbers, basics of vectors, introduction to matrices.
Unit II Calculus 6 lectures	Differential calculus (limits, derivatives), integral calculus (integrals, sequences and series *etc*.).
Unit III Mathematical models in biology 6 lectures	Population dynamics; oscillations, circadian rhythms, developmental patterns, symmetry in biological systems, fractal geometries, size-limits & scaling in biology, modelling chemical reaction networks and metabolic networks.
Unit IV Statistics 8 lectures	Probability: counting, conditional probability, discrete and continuous random variables; Error propagation; Populations and samples, expectation, parametric tests of statistical significance, nonparametric hypothesis tests, linear regression, correlation & causality, analysis of variance, factorial experiment design.

Recommended Textbooks and References:

1. Stroud, K. A., & Booth, D. J. (2009). *Foundation Mathematics*. New York, NY: Palgrave Macmillan.
2. Aitken, M., Broadhursts, B., & Haldky, S. (2009) *Mathematics for Biological Scientists*. Garland Science.
3. Billingsley, P. (1986). *Probability and Measure.* New York: Wiley.
4. Rosner, B. (2000). *Fundamentals of Biostatistics*. Boston, MA: Duxbury Press.
5. Daniel, W. W. (1987). *Biostatistics, a Foundation for Analysis in the Health Sciences*. New York: Wiley.

Biochemistry **COURSE CODE: 20MS1BT111** **L-T-P: 3-0-0** Credits 3	**Course objective** Following are the objectives of Biochemistry course. ▪ To understand the basic biochemical processes and their principles those govern complex biological systems. ▪ To understand the structure, functions of essential biomolecules and their interactions with each other. ▪ To understand the various metabolic and energy generation processes which are essential for sustainability of life.	**Students Learning outcomes** After learning and completion of Biochemistry course, student will be able to: ▪ Define the structural features of basic biomolecules ▪ Describe the functionality of biomolecules in relation to their usage for steady state of an organism. ▪ Get complete understanding of metabolic processes and their integration with each other.

Unit/ Module	Description
Unit I: Origin of Life (Biochemical basis) 4 lectures	Chemical basis of life: Miller-Urey experiment, abiotic formation of amino acid oligomers, composition of living matter; Water and its essential role for life, pH and its regulation in relation to microorganisms
Unit II: Biomolecules in Microbial world 8 lectures	**Carbohydrates:** Classification, basic chemical structures and their role in microbial life. **Lipids:** Classification, structure and function of major lipid subclasses in microbe's especial consideration bacterial membranes. **Proteins:** Amino acids: Classification, Properties, Protein Structure: primary, secondary, tertiary and quaternary structure, basics of enzymes and their catalysis. **Nucleotides:** Nucleotides, Nucleosides structures, Different confirmations of DNA
Unit III: Microbial nutrition and basic biochemical process for growth 4 lectures	Microbial metabolic diversity and classification based on nutritional types. Transport Mechanisms across membrane: Diffusion, facilitated Diffusion, Active and passive transport.
Unit IV: Central Metabolic Pathways and Carbohydrate metabolism 10 lectures	Bacterial aerobic respiration, Embden-Meyerhof pathway, Entner-Doudoroff pathway, Pentose phosphate pathway, Tricarboxylic acid cycle, components of electron transport chain, chemiosmotic theory, oxidative and substrate level phosphorylation, , Utilization of sugars other than glucose and complex polysaccharides. Bacterial anaerobic respiration and fermentation
Unit IV: Metabolism of lipids and hydrocarbons: 6 lectures	Biosynthesis and degradation of fatty acids and phospholipids, lipopolysaccharide biosynthesis
Unit V: Protein and amino-acid metabolism 6 lectures	Metabolism of amino acids: Amino acid biosynthesis and utilization, lysine and glutamine overproduction, polyamine biosynthesis and regulation.
Unit VI: Metabolism of nucleotides 4 lectures	Purine and pyrimidine biosynthesis, regulation of purine and pyrimidine biosynthesis, inhibitors of nucleotide synthesis.

Recommended Textbooks and References:

1. J M Berg, L Stryer, J Tymoczko, G Gatto, “Biochemistry”, 9th Ed., (2019) W H Freeman
2. D L Nelson and MM Cox, “Lehninger Principles of Biochemistry”, 7th Ed. (2017) WH Freeman
3. J Willey, L Sherwood, C J Woolverton “Prescott's Microbiology”, 10th Ed., (2016) Mc GRaW-Hill

	Course objective	Students Learning outcomes
Molecular Biology **COURSE CODE: 21MS1MB112** **L-T-P: 3-0-0** Credits 3	The objective of this course is to equip students with detailed knowledge of molecular biology, applications of molecular biology, and enhance their abilities to understand modern research and developments in the life science sector.	On successful completion of this course, student will be able to: ▪ Understand physical and chemical properties nucleic acids ▪ Develop deep understanding about DNA replication, damage and repair ▪ Understand the processes of transcription and translation at molecular level ▪ Will recognize the different mechanism of gene regulation in microbial systems ▪ Will get apprised with different molecular biology techniques and their applications in modem research and life science sector

Unit I **Chemical and Physical Properties of Nucleic acids** 3 lectures	Introduction to molecular Biology; Chemical and physical properties of Nucleic acids
Unit II **DNA replication Damage and repair** 8 lectures	DNA replication, Nature of replication, Enzymes and proteins involved, Replication Fork and priming, leading and lagging strand, Process of Replication: initiation elongation, termination, specific features of replication in Prokaryotes, fidelity of replication, inhibitors of replications and their applications, DNA damage repair and recombination: DNA damage, DNA Mismatch Repair, Double Strand Break Repair, Homologue and site-specific recombination,
Unit III **RNA synthesis and processing** 8 lectures	Transcription: Transcription machinery of prokaryotes, various transcription enzymes and cofactors, initiation, elongation and termination, sigma factors, post-transcriptional processes: RNA processing, splicing, capping and polyadenylation, rRNA and tRNA processing, RNAi and miRNAs, post-transcriptional gene regulation.
Unit IV **Protein synthesis and processing** 8 lectures	Translation: Mechanisms of translation in prokaryotes, initiation complex, ribosomes and tRNA, factors, aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetase, and translational proof-reading, translational elongation and termination, inhibitors of translation

Unit V **Gene Regulation expression** 8 Lectures	Control of gene expression at transcription and translation level regulating the expression of phages, viruses, prokaryotic and
Unit VI **Molecular Biology Techniques** 7 Lectures	Labelling of DNA: nick translation, random priming, radioactive and non-radioactive probes, Hybridization techniques: northern, southern, fluorescence in situ hybridization, Polymerase chain reaction and its variations

Recommended Textbooks and References:

Suggested Text Book(s):

1. Lehninger "Principles of Biochemistry".
2. Principles of Genetics – D. Peter Snustad, Michael J. Simmons

Suggested Reference Book(s):

1. Lewin's GENES XI
2. Lodish H, Berk A, Zipursky LS, Matsudaira P, Baltimore D, Darnell J (2000). Molecular Cell Biology.
3. W. H. Freeman and Company
4. Molecular Biology of the Gene by J.D. Watson, T.A. Baker, S.P. Bell, A. Gann, M. Levin, R. Losick, 6th edition, Benjamin Cummings, San Francisco, USA, 2007.
5. Molecular Biology by R.F. Weaver, 4th edition, McGraw Hill. New York. USA, 2007.
6. Molecular Biology of the Cell by B. Alberts, A. Johnson, J. Lewis, M. Raff, K. Roberts, P. Walter, 5th edition, Garland Science, New York and London, 2007. 5.

VIROLOGY COURSE CODE: 20B1WB831 L-T-P: 2-0-0 Credits: 3	**Course Objectives** To acquaint the students with the development and techniques of virology useful in biotechnology industry. Scientific evaluation of various characteristics of viruses, their metabolism and role in various domains of life.	**Students Learning outcomes** Students should be able ▪ To acquire the knowledge about fundamental concepts related virology and its history ▪ Scientifically test the hypothesis provided under a given situation involving microbial world and demonstrate practical skills in basic virological techniques including growth and control of viruses ▪ Analyze and interpret the experiments/pathways relevant to virus analysis

Unit 1 **Introduction and classification of viruses** 4 Lectures	Brief outline on discovery and origin of viruses. General properties of viruses, Classification and general properties of major families of viruses
Unit 2 **Structure and morphology of viruses** 4 Lectures	Morphology and ultra-structure of viruses, capsid and their arrangements, types of envelopes and their composition, measurement of viruses. Viral genome; their types and structure, viral related agents-viroids and prions.
Unit 3 **Cultivation and analytical techniques in virology** 7 Lectures	Cultivation of viruses in embryonated eggs, experimental animals, and cell cultures; primary and secondary cell cultures; suspension cell cultures and monolayer cell cultures; cell strains, cell lines and transgenic systems; serological methods – haemagglutination and HAI; complement fixation; immunofluorescence methods, ELISA and Radioimmuno assays; assay of viruses – physical and chemical methods (protein, nucleic acid, radioactivity tracers, electron microscopy) – Infectivity assay (plaque method, end point method) – Infectivity assay of plant viruses.
Unit 4 **Viral replication; uncoating, assembly and release** 6 Lectures	Bacteriophage: classification, morphology and ultra structure. One step growth curve (latent period, eclipse period, and burst of size.) Life cycle: lytic and lysogenic life cycle of bacteriophages. Brief account of M13, Mu, T4, Ø x174 and lambda phage. Uncoating, assembly and release

Unit 5 **Plant viruses: Infection and diseases of plants** 7 Lectures	Classification and nomenclature; effects of viruses on plants; appearance of plants; histology, physiology and cytology of plants; common virus diseases of plants; paddy, cotton, tomato and sugarcane; viruses of cyanobacteria, algae, fungi, life cycle; type species of plant viruses like TMV, Cauliflower Mosaic Virus and Potato Virus X; transmission of plant viruses with vectors (insects, nematodes, fungi) and without vectors (contact, seed and pollens); diagnostic techniques in seeds; seed stocks and diseased plants (seed morphology, seedling symptomatology, indicator plants, serological methods, histochemical tests and fluorescent microscopy); prevention of crop loss due to virus infection – virus- free planting material; vector control
Unit 6 **Animal viruses: infections and diagnosis** 7 Lectures	Classification and nomenclature of animal human viruses; epidemiology, lifecycle, pathogenicity, diagnosis, prevention and treatment of RNA virurses Picorna, Ortho myxo, Paramyxo, Toga and other arthropod viruses, Rhabdo, Rota, HIV and other Oncogenic viruses; DNA viruses; Pox, Herpes, Adeno, SV 40; Hepatitis viruses.
Unit 7 **Viral vaccines and antiviral agents** 7 Lectures	Viral vaccines (conventional vaccines, genetic recombinant vaccines used in national immunization programmes with examples, newer generation vaccines including DNA vaccines with examples) interferons and antiviral drugs.

Recommended Textbooks and References:

1. Reference Books 1. Virology; Renato Dulbecco and Harold S. Ginsberg

2. An Introduction to viruses, S. B. Biswas and Amita Biswas. Forth edition, Vikas Publishing House PVT LTD New Delhi.

	Course objective	Students Learning Outcomes
Fungal Biology COURSE CODE: 21MS1MB113 L-T-P: 3-0-0 Credits 2	The objectives of this course are to introduce field of field biology with special emphasis on fungal diversity, morphology, physiology and reproduction; their application to industry and a human-host or plant-fungal interactions.	Students should be able to: Identify major categories of fungi and analyze their classification, diversity, and ubiquity Identify major categories of fungi, demonstrate and evaluate interactions between hosts (plant/human) and environment.

Unit I **Introduction and classifications** 3 lectures	Introduction to the course; characteristics of fungi Fungal life cycles, ecological role of fungi, and human-fungus interactions, Model organisms and genetics
Unit II **Division or Phylum Zygomycota** 04 lectures	**General overview** **Class Zygomycetes (Order Mucorales)** Fermented Foods etc
Unit III **Division or Phylum Basidiomycota (General overview) Class Basidiomycetes** 07lectures	Cultivation of mushrooms & other fungi Spore release and dispersal Poisonous and hallucinogenic mushrooms; Mycotoxins in the grain and other food products. **Class Urediniomycetes & Ustomycetes (Rusts and Smuts)**
Unit IV **Division or Phylum Ascomycota** 08 lectures	**General overview** Ergot & ergotism; Mycotoxins in Food Alcoholic fermentations, cheeses, and fungal metabolites Physiology of Fungal Growth Bioremediation Yeast-Model organism and expression system
Unit V **IMPERFECT FUNGI** **FUNGUS-LIKE ORGANISMS** 7 lectures	**Form Division or Form Phylum Deuteromycota: (General overview)** Symbiotic and Parasitic relations Allergies and Fungal Diseases of Animals & Humans Slime molds Zoosporic Fungi: Chytrids, Oomycetes, and others

Recommended Textbooks and References:

1. Introduction to Fungi. 3rd Edition (2007) Webster & Webster. Cambridge University Press.
2. Bessette, A. E., Bessette, A. F., & Lewis, D. P. (2019). Mushrooms of the Gulf Coast States: A Field Guide to Texas, Louisiana, Mississippi, Alabama, and Florida. University of Texas Press.
3. https://fungalbiolbiotech.biomedcentral.com/articles
4. https://www.frontiersin.org/research-topics/9823/innovative-approaches-in-diagnosis-of-emergingre-emerging-infectious-diseases
5. https://www.frontiersin.org/research-topics/11600/fungal-genetics-in-plant-biomass-conversion
6. https://www.frontiersin.org/research-topics/13305/plant-pathogenic-fungi-molecular-systematics-genomics-and-evolution

General Microbiology and Bacteriology Lab COURSE CODE: 21MS7MB171 L-T-P: 0-0-4 Credits: 2	**Course Objectives** The objective of this laboratory course is to provide practical skills on basic microbiological techniques.	**Students Learning outcomes** Students should be able to: ▪ Isolate, characterize and identify ▪ Common bacterial organisms ▪ Determine bacterial load of different samples ▪ Perform antimicrobial sensitivity tests ▪ Preserve bacterial cultures.

Syllabus:

1. To study construction and working of compound microscope and study of microbiology lab instruments
2. Sterilization, disinfection and safety in microbiological laboratory.
3. Preparation of media for cultivation of bacteria.
4. Isolation of bacteria in pure culture by streak plate method.
5. Pour plate technique and study of colony and growth characteristics of some common bacteria
6. Preparation of bacterial smear and Gram's staining.
7. Acid-fast staining for study and differentiation of acid-fast bacteria.
8. Enumeration of bacteria: serial dilution and standard plate count.
9. Antimicrobial sensitivity test and demonstration of drug resistance
10. Determination of Minimum Inhibitory Concentration (MIC)
11. Maintenance of stock cultures: slants, stabs and glycerol stock cultures
12. Determination of phenol co-efficient of antimicrobial agents.
13. Isolation and identification of bacteria from soil/water samples.
14. Study of bacterial growth kinetics.

Recommended Textbooks and References:

1. Cappuccino, J. G., & Welsh, C. (2016). *Microbiology: a Laboratory Manual*. Benjamin-Cummings Publishing Company.
2. Collins, C. H., Lyne, P. M., Grange, J. M., & Falkinham III, J. (2004). *Collins and Lyne's Microbiological Methods* (8th ed.). Arnolds.
3. Benson, Harold J. (2007) *Microbiological Applications : Laboratory Manual in General Microbiology*, McGraw-Hill Higher Education
4. Tille, P. M., & Forbes, B. A. *Bailey & Scott's Diagnostic Microbiology.*

BIOCHEMISTRY LAB COURSE CODE: 21MS7BT171 L-T-P: 0-0-2 Credits: 1	**Course Objectives** The Objective of the course is ▪ To provide training and skills for the handling and analysis of biomolecules. ▪ To acquaint the students with laboratory techniques related to detection and estimation of primary biomolecules which are essential in an organism for life sustainability.	**Students Learning outcomes** After completion of Biochemistry lab, student will be able ▪ To understand the basic biochemistry laboratory practices and independently handle different instruments utilized in a biochemistry lab. ▪ To identify and quantify accurately different biochemical identities in a given sample. ▪ To observe, analyze and record the results of biochemical experiments and independently draw reasonable conclusions from results.

Syllabus:

1. Basic guidelines for safety measures to avoid hazards in biochemistry lab and preparing various stock solutions and working solutions.
2. To prepare buffer solution of varying pH by using Henderson-Hasselbalch equation and pH meter.
3. To identify and classify different sugars on the basis of qualitative methods.
4. To determine concentration of carbohydrates by Anthrone method: a quantitative approach.
5. To isolate the proteins from bacterial culture using differential centrifugation and their detection using qualitative methods.
6. To estimate concentration of proteins with Bradford's method.
7. To estimate concentration of proteins by Lowry's method.
8. To separate different bacterial proteins using SDS PAGE technique.
9. To study the enzyme activity (amylase enzyme) using DNS method.
10. To determine an unknown protein concentration by plotting a standard graph of BSA using UV-Vis Spectrophotometer and validating the Beer- Lambert's Law.
11. To determine presence of lipid in a given sample through qualitative method.
12. To Estimate the Saponification value of oils.
13. To quantify the concentration of DNA using spectrophotometer.
14. To detect the presence of microorganism in milk using specific biochemical tests.

Recommended Textbooks and References:

1) Irwin H. Segel "Biochemical Calculations", 2ed (2010) Wiley
2) Andreas Hofmann & Samuel Clokie Wilson and Walker's "Principles and Techniques of Biochemistry and Molecular Biology" (2018) Cambridge university press

Molecular Biology Lab **COURSE CODE: 21MS7MB172** **L-T-P: 0-0-4** Credits 1	**Course objective** The objective of this course is to familiarize the students with some basic and advanced techniques of molecular biology.	**Students Learning outcomes** On successful completion of this course, student will be able to: ▪ Understand the fundamentals of procedure of isolation, quantification and visualization of various biomolecules from different cellular or tissue. ▪ Interpret and conclude experimental results involving molecular biology

Syllabus

1. Introduction to molecular biology lab and facilities, Calculations of molarity and normality of the solutions
2. Preparation of Buffer Stocks (TBE, TAE, TE) and Buffers for gel electrophoresis
3. To perform agarose gel electrophoresis of DNA samples
4. Estimation of DNA quantity and quality by gel electrophoresis
5. To isolate genomic DNA from *E. coli* (DH5-α) using heat boiling method
6. To isolate *E. coli* (DH5-α) genomic DNA using phenol chloroform
7. Isolation of genomic DNA from human blood sample
8. Preparation of reagents and isolation plant genomic DNA using CTAB method
9. Quantification of DNA concentration and purity by spectrometric/nanodrop method
10. Introduction to Polymerase Chain Reaction and to amplify gene using genomic DNA of *E. coli.*
11. To separate serum and plasma proteins from human blood
12. To visualize human serum and plasma proteins using SDS-PAGE technique
13. To isolate RNA from bacterial cell and its quantification

Recommended Textbooks and References:

1. Green, M. R., & Sambrook, J. (2012). *Molecular Cloning: A Laboratory Manual.* Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.

Good Laboratory Practice and Bioinstrumentation Lab COURSE CODE: 21MS7MB173 L-T-P: 0-0-2 Credits: 1	**Course Objectives** The Objective of the course is to provide training of good laboratory practices and various instrumentations used in Biotech/Pharmaceutical industry. This course covers practical aspects of modern instrumentation used for analysis in biological research	**Students Learning outcomes** Students should be able to: ▪ To understand basic guidelines, importance of good laboratory practice, documentation and conduct of non-clinical studies ▪ To Understand basic principles and applications of bio-instruments ▪ To develop necessary critical thinking skills in order to do data analysis and interpretation in relation to the research process

Syllabus:

1. To introduce good lab practices, Lab safety and Bio hazard
2. Introduction to the OECD Principles of good laboratory practice. Overview and Purpose of GLP
3. Good Documentation practice and maintenance of lab note book
4. Quality control & Quality Assurance in laboratory
5. To determine an unknown protein concentration by plotting a standard graph of BSA using UV-Vis Spectrophotometer and validating the Beer- Lambert's Law.
6. Instrumentation and working principles of infra red (IR) spectroscopy using salt plates.
7. Chromatography (Ion exchange, Molecular Sieve, Affinity, Thin layer, GC)
8. Instrumentation and working principles of HPLC
9. Instrumentation and working principles Electron Microscopy
10. Principle and application Gel electrophoresis
11. Principle and application of lypholization
12. Instrumentation and working principles of mass spectroscopy
13. Determination of molar mass of simple compounds using mass spectroscopy.
14. MALDI-TOF instrumentation and analysis of serum proteins
15. To study the effect of chemical denaturants on protein stability using CD spectroscopy.
16. Principle and applications of Centrifugation and ultracentrifugation

Recommended Textbooks and References:

1. Milton. A. Anderson (2002) GLP Essentials: a Concise Guide to Good Laboratory Practices
2. Sandy Weinberg (2007) Good Laboratory Practice Regulations
3. Nally, J. D. 6th edition. CRC Press (2006) *GMP for Pharmaceuticals*
4. Andreas Hofmann & Samuel Clokie Cambridge university press (2018) Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology

IInd SEMESTER (MBII)

	Course objective	Students Learning outcomes
Immunology and Immunotechnology **COURSE CODE: 18MS1BT211** **L-T-P: 3-0-0** Credits 3	The objectives of this course are to learn about structural features of components of immune system as well as their function. The major emphasis of this course will be on development of immune system and mechanisms by which our body elicits immune response. This will be imperative for students as it will help them to predict about nature of immune response that develops against bacterial, viral or parasitic infection, and prove it by designing new experiments.	On successful completion of this course, student will be able to: • Evaluate usefulness of immunology in different pharmaceutical companies; • Identify proper research lab working in area of their own interests; • Apply their knowledge and design immunological experiments to demonstrate innate, humoral or cytotoxic T lymphocyte responses and figure out kind of immune responses in the setting of infection (viral or bacterial).

Unit I **Immunology fundamental Concepts:** 6 lectures	Historical perspectives, Cells and organs of the immune system, Types of immunity (innate and acquired immunity), Components of innate and acquired immunity, Antigens: mitogens Immunogenicity, antigenicity, epitopes, haptens.
Unit II **Immune responses generated by B and T lymphocytes** 8 lectures	Immunoglobulins - basic structure, classes & subclasses of immunoglobulins, antigenic determinants, B-cell receptor, B cell maturation, activation and differentiation; generation of antibody diversity; T-cell maturation, activation and differentiation and T-cell receptors; functional T Cell subsets; cell-mediated immune responses, ADCC; cytokines: properties, receptors and therapeutic uses; antigen processing and presentation- endogenous antigens, exogenous antigens, non-peptide bacterial antigens and super-antigens; cell-cell co-operation, Hapten-carrier system,
Unit III **Antigen-antibody interactions** 5 lectures	Precipitation, agglutination and complement mediated immune reactions; advanced immunological techniques: RIA, ELISA, Western blotting, ELISPOT assay, immunofluorescence microscopy, flow cytometry and FACS.
Unit IV **Vaccinology** 7 lectures	A short history of vaccination, Active and passive immunization; live, killed, attenuated, subunit vaccines; vaccine technology: role and properties of adjuvants, recombinant DNA and protein based vaccines, plant-based vaccines, reverse vaccinology; peptide vaccines, conjugate vaccines; antibody genes and antibody engineering:chimeric, generation of monoclonal antibodies, hybrid monoclonal antibodies; catalytic antibodies and generation of immunoglobulin

Unit V **Clinical immunology** 8 Lectures	Autoimmunity: Types of autoimmune diseases (organ specific and systemic), Mechanisms of autoimmunity, Hypersensitivity reactions: Type I, II, II and IV, hypersensitivity reactions, treatment of autoimmune diseases; transplantation: immunological basis of graft rejection; clinical transplantation and immunosuppressive therapy
Unit VI **Immune response to infectious diseases and tumor immunity** 4 Lectures	Viral, bacterial, protozoan diseases, parasitic infections, Immunodeficiency diseases: Primary and secondary immunodeficiency diseases, Acquired immunodeficiency syndrome (AIDS)
Unit VII **Immunogenetics** 4 Lectures	Major histocompatibility complex genes and their role in autoimmune and infectious diseases, HLA typing. General organization and inheritance of MHC, structure of MHC class I and II molecules, peptide binding by MHC molecules, MHC and susceptibility to disease.

Recommended Textbooks and References:

1. Kindt, T. J., Goldsby, R. A., Osborne, B. A., & Kuby, J. (2006). Kuby Immunology. New York: W.H. Freeman.
2. Brostoff, J., Seaddin, J. K., Male, D., & Roitt, I. M. (2002). Clinical Immunology. London: Gower Medical Pub.
3. Murphy, K., Travers, P., Walport, M., & Janeway, C. (2012). Janeway's Immunobiology. New York: Garland Science.
4. Paul, W. E. (2012). Fundamental Immunology. New York: Raven Press.
5. Goding, J. W. (1996). Monoclonal Antibodies: Principles and Practice: Production and Application of Monoclonal Antibodies in Cell Biology, Biochemistry, and Immunology. London: Academic Press.
6. Parham, P. (2005). The Immune System. New York: Garland Science.

Enzymes & Bioprocess Technology **COURSE CODE: 21MS1MB211** **L-T-P: 3-0-0** Credits 3	**Course objective** The objectives of this course are to develop an understanding in students about the fundamental and important concepts of enzymes and bioprocess technology and its related applications, thus preparing them to meet the challenges of the new and emerging areas of biotechnology industry.	**Students Learning outcomes** On successful completion of this course, student will be able to: • Describe the fundamentals and importance of enzymes and its kinetics • Appreciate relevance of microorganisms from industrial context • Analyze bacterial growth kinetics in batch/continuous/Fed-batch reactor and thermal death kinetics • Give an account of bioreactor design and their applications • Calculate yield and production rates, the need for oxygen and oxygen transfer in a biological production process, and also interpret data; • Apply principles of various unit operations in designing and optimization of downstream processes • Give an account of importance of enzymes and microbials in food processing and production of various bioproducts.

Unit I **Enzymology** 5 lectures	Introduction to Enzymes; Classification; General properties; Kinetics; Reversible and irreversible inhibition; Coenzyme and cofactors; Isoenzymes
Unit II **Basic Principles of Bioprocess Technology** 4 lectures	Introduction to fermentation; Isolation, screening, preservation and maintenance of industrially important microbes; Strain improvement
Unit III Bioreactor Design and Analysis 10 lectures	Microbial growth and Death Kinetics; Factors affecting microbial growth; Batch and Continuous Fermentation; Modifying Batch and continuous Fermentation: Fed-batch, Chemostat with recycle, multistage chemostat systems; Cell and enzyme immobilization Criteria for ideal fermenter; Configuration; Bioreactor designs-mechanically agitated; Pneumatic and hydrodynamic fermenters. Whole Cell Immobilized Fermenters; Stability of microbial reactors
Unit IV **Upstream processing**	Fermentation media; Media formulation; Sterilization; Aeration, agitation and heat transfer in bioprocess; Measurement and control of bioprocess parameters; Scale up and scale down process

6 lectures	
Unit V Downstream processing and Product Recovery 7 Lectures	Separation of insolubles: Filtration, Centrifugation, Sedimentation; Cell disruption; Separation of solubles: Liquid-liquid extraction; Precipitation; chromatographic techniques; Reverse osmosis and ultra and micro filtration; Final purification: Drying; Crystallization; Storage and packaging; Effluent Treatment and its disposal
Unit VI Applications of Enzyme technology in food processing 4 Lectures	Mechanism of enzyme function and reactions in process techniques; enzymatic bioconversions *e.g.* starch and sugar conversion processes; high-fructose corn syrup; hydrolyzed protein *etc.* and their downstream processing; baking by amylases, deoxygenation and desugaring by glucoses oxidase, beer mashing and chill proofing; cheese making by proteases and various other enzyme catalytic actions food processing
Unit VII Applications of microbial technology in bioproduct production 6 Lectures	Industrial Production of Bioproducts: Ethanol, Acids (Citric, acetic, Lactic and gluconic), Antibiotics (Penicillin, streptomycin, tetracycline), Semi-synthetic antibiotics, Ethanol, Single Cell Protein

Recommended Textbooks and References:

1. Berg, J.M., Tymoczko, J.L. and Stryer, L., "*Biochemistry*", 5th ed., W.H. Freeman and Company, New York, 2002
2. Nelson D.L., Cox M.M., "Lehninger Principles of Biochemistry", 5th ed., W.H. Freeman and Company, New York, 2008.
3. Pauline M. Doran, "Bioprocess Engineering Principles", 8th ed., Academic press, New York, 2003.
4. M.L. Shuler and F. Kargi, "Bioprocess Engineering--basic Concepts", 2nd Edn. Prentice-hall Of India Pvt Ltd (2008).
5. Peter F. Stanbury, Stephen J. Hall & A. Whitaker, "Principles of Fermentation Technology", Â Elsevier India Pvt Ltd. (2007).
6. Jackson AT., Bioprocess Engineering in Biotechnology, Prentice Hall, Engelwood Cliffs, 1991.
7. Illanes A, "Enzyme Biocatalysis", Springer Science, 2008.
8. Klaas Van't Riet, Johannes Tramper, "Basic Bioreactor Design", 2nd ed., Marcel Dekker, Inc., New York, 1991.
9. JE Bailey and DF Ollis, "Biochemical Engineering Fundamentals", 2nd ed., McGraw-Hill Book Company, New York, 1986.
10. Mansi EMTEL, Bryle CFA. Fermentation Microbiology and Biotechnology, 2nd Edition, Taylor & Francis Ltd, UK, 2007.
11. Abhilasha S. Mathuriya, "Industrial Biochnology" 1st ed., Ane Books Pvt. Ltd., New Delhi, 2009.

Microbial Genetics and Physiology **COURSE CODE: 21MS1MB212** **L-T-P: 3-0-0** Credits 3	**Course objective** The objectives of this course are to take students through basics of genetics and physiology covering prokaryotic/phage genetics to yeast and higher eukaryotic domains. Students will be exposed to concepts of population genetics, quantitative genetics encompassing complex traits, genetics of evolution, microbial metabolism, energy generation, microbial communication and energetics.	**Students Learning Outcomes** On successful completion of this course, student will be able to: ▪ Describe fundamental molecular principles of genetics. ▪ Describe the basics of genetic mapping. ▪ Understand the principles of Population genetics. ▪ Acquaint with energy generation and fermentation pathways. ▪ Acquaint with energetics of Chemolithotrophs, and microbial cross-talk

Unit I Genetics of bacteria, bacteriophages, and Yeast 10 lectures	Concept of a gene in pre-DNA era; mapping of genes in bacterial and phage chromosomes by classical genetic crosses; fine structure analysis of a gene; genetic complementation and other genetic crosses using phenotypic markers; Yeast mating type switch; dominant and recessive genes/mutations, complementation groups, transposon mutagenesis, Mapping QTLs
Unit II **Drosophila genetics as a model of higher eukaryotes** 5 lectures	Analyses of autosomal and sex linkages, screening of mutations based on phenotypes and mapping the same, hypomorphy, genetic mosaics
Unit III **Population genetics and genetics of evolution** 7 lectures	Introduction to the elements of population genetics: genetic variation, genetic drift, neutral evolution; mutation selection, Fishers theorem, Hardy Weinberg equilibrium, in-breeding depression & mating systems; population bottlenecks
Unit IV Microbial Physiology 10 lectures	Metabolic genetic regulation, Energy, oxidation-reduction vs. fermentation, Microbial growth: Growth cycle, continuous culture, factors affecting growth. Regulatory systems during aerobic- anaerobic shifts. Osmotic control of gene expression, SOS response and Heat shock response, Phosphate starvation
Unit V Energetics of autotrophs and chemolithotrophs 10 Lectures	pH Homeostasis, specific transport systems, Fermentation pathways in specific group of microorganisms: Lactic acid, propionic acid, butyric acid producing fermentation; Characteristics and Metabolism of autotrophs; Biosynthesis of Fatty acids; Degradation of Lipids, Endospore formation (differentiation). Bacterial Quorum sensing

Recommended Textbooks and References:

1. Hartl, D. L., & Jones, E. W. Genetics: Principles and Analysis. Sudbury, MA: Jones and Bartlett.

2. Pierce, B. A. Genetics: a Conceptual Approach. New York: W.H. Freeman.

3. Tamarin, R. H., & Leavitt, R. W. Principles of Genetics. Dubuque, IA: Wm. C. Brown.

4. Smith, J. M. Evolutionary Genetics. Oxford: Oxford University Press.

5. Klug, W.S., Cummings, R., Spencer, C. A., & Michael A. P., Concepts of Genetics. Pearson Publications

6. Albert G. M., & John W. F., Microbial Physiology, Wiley-Liss, A John Wiley& Sons, Inc. Publications.

7. Trudy T. A, Endang P. et al, Microbial Physiology and Genetics. Intelliz Press,

8. Davis K. Microbial Physiology and Genetics. Apple Academic Press.

Recombinant-DNA Technology **COURSE CODE: 18MS1BT313** **L-T-P: 3-0-0** **Credit 3**	**Course objective** The objectives of this course areto teach students with various approaches to conducting recombinant DNA technology and their applications in biological research as well as industries.	**Students Learning outcomes** Given the impact of recombinant DNA technology in modern society, the students should be endowed with strong theoretical knowledge of this technology. In conjunction with the practical in molecular biology & genetic engineering, the students should be able to take up biological research as well as placement in the relevant biotech industry.

Unit I **Introduction and tools for rDNA technology** 3 lectures	Recombinant DNA technology: gene cloning, Genetic engineering, - concept and basic steps - rDNA Glossary, history of rDNA-recombinant Insulin
Unit II **DNA modifying enzymes and cloning techniques** 06 lectures	Restriction Endonucleases, DNA Ligation Enzymes and, DNA Modifying Enzymes: Nucleases, Kinases, phosphatases, and Reverse transcriptase other tools used for DNA Modification
Unit III **Cloning Vectors and Expression Vectors** 12 lectures	Plasmid Vectors, Vectors based on Lambda Bacteriophage, Cosmids, M13 Vectors, Vectors for Cloning Large DNA Molecules Principles for maximizing gene expression, expression vectors; pMal; GST; pET-based vectors; Protein purification; His-tag; GST-tag; MBP-tag *etc.*; Inclusion bodies; methodologies to reduce formation of inclusion bodies; mammalian expression and replicating vectors; Baculovirus and *Pichia* vectors system, plant-based vectors, Ti and Ri as vectors, yeast vectors, shuttle vectors
Unit IV **Construction libraries and sequencing technologies** 10 lectures	Genomic library, cDNA library, Growing & Storing Libraries, construction of microarrays, cDNA Cloning (5'&3' RACE) Basic DNA Sequencing, Whole genome sequencing, Next generation sequencing technologies
Unit V **Gene Expression in Microbial and Eukaryotic Systems** 06 lectures	Microbial, Yeast Saccharomyces *Cerevisiae* as heterologous protein expression platforms, Protein expression in insect Cells and Mammalian Cells; protein-protein interactions using yeast two-hybrid system;
Unit VI **Genetic Manipulation Of microorganisms** 05 lectures	Gene transfer techniques, Application of Genetically Engineered Strains of microbes; Biosafety Issues related to recombinant DNA Technology Genetic Manipulation of microorganisms

Approved in Academic Council Meeting held on 28 July, 2021

Recommended Textbooks and References:

1. Old, R. W., Primrose, S. B., & Twyman, R. M. (2001). *Principles of Gene Manipulation: an Introduction to Genetic Engineering*. Oxford: Blackwell Scientific Publications.
2. Green, M. R., & Sambrook, J. (2012). *Molecular Cloning: A Laboratory Manual*. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.
3. Brown, T. A. (2006). *Genomes* (3rd ed.). New York: Garland Science Pub.
4. Selected papers from scientific journals, particularly Nature & Science.
5. Technical Literature from Stratagene, Promega, Novagen, New England Biolab *etc.*

Bioinformatics **MBII** **COURSE CODE: 20MS1BT213** **L-T-P: 2-0-0** Credits 2	**Course objective** The objectives of this course are to provide theory and practical experience of the use of common computational tools and databases which facilitate investigation of molecular biology and evolution-related concepts.	**Students Learning outcomes** On successful completion of this course, student will be able to: ▪ Develop an understanding of basic theory of these computational tools; ▪ Gain working knowledge of these computational tools and methods; ▪ Prediction of structure from sequence and subsequently testing the accuracy of predicted structures ▪ Appreciate their relevance for investigating specific contemporary biological questions; ▪ Critically analyse and interpret results of their study.

Unit I **Introduction** 4 lectures	Bioinformatics basics: Protein and nucleic acid databases; Structural databases; search tools: biological background for sequence analysis; searching of databases similar sequence; NCBI; publicly available tools; resources at EBI; sequence, sequence similarity, homology, alignment.
Unit II **Pairwise Sequence Alignment** 6 lectures	Different scoring models, Substitution matrices (PAM and BLOSUM), Pairwise Alignment: Concept of Global and Local Alignment, Dot matrix method, Dynamic programming (Needleman-Wunsch algorithm, Smith-Waterman algorithm, Choosing of best scoring matrix, gap penalties, Significance of score, FASTA and BLAST algorithms.
Unit III **Multiple Sequence alignment** 6 lectures	Multiple Sequence Alignment methods (MSA), Scoring of a MSA, Progressive (CLUSTALW and PILEUP), Iterative (Genetic) and Hidden Markov Model (HMM) based methods of MSA, Profile and BLOCK level analysis, Motif and Pattern searching and primer designing.
Unit IV **Phylogenetic Analysis** 4 lectures	Molecular evolution basics, phylogenetic tree and terminology, different methods of Phylogenetic tree prediction: maximum parsimony, distance (UPGMA, NJ), maximum likelihood methods, Phylogenetic and evolutionary analysis.
Unit V Structural Alignment Tools and Protein Tertiary Structure Prediction 5 Lectures	Protein structure prediction: protein folding and model generation; secondary structure prediction; analyzing secondary structures; homology modelling: potential applications, description, methodology, homologous sequence identification; align structures, align model sequence; construction of variable and conserved regions; structure aided sequence techniques of structure prediction; structural profiles.
Unit VI **RNA Structure Analysis**	terminology of RNA secondary structure, inferring structure by comparative sequence analysis, RNA secondary structure prediction, Basic algorithms and methods of RNA folding.

3 Lectures	

Recommended Textbooks and Reference books:

Text Books:

1. D.W. Mount *Bioinformatics: Genome and Sequence Analysis*: (2001) Cold Spring Harbor Laboratory Press, Cold Spring Harbor, New York.
2. Ian Korf, Mark & Josaph: *BLAST*, Oreilly Publisher, 2003
3. R. Durbin, S. Eddy, A. Krogh and G. Mitchison, *Biological Sequence Analysis: Probabilistic Models of Proteins and Nucleic Acids.* Cambridge University Press.
4. J. Pevsner (2002) Bioinformatics and Functional Genomics; Cold Spring Harbor Laboratory Press, Cold Spring Harbor, New York.
5. A.D. Baxevanis & B.F.F. Oulette *Bioinformatics – A practical guide to the Analysis of Genes and Proteins*,2002, Willey International publishers.
6. M.J. Bishop and C.J. Rawlings (editors), *DNA and Protein Sequence Analysis---A Practical Approach* IRL Press at Oxford University Press, ISBN 0 19 963464 7 (Pbk)
7. Lesk, A. M. (2002). *Introduction to Bioinformatics*. Oxford: Oxford University Press.

Reference Books:

1. J. Setubal and J. Meidanis (1997) *Introduction to Computational Molecular Biology,* PWS Publishing Co.

2. J. Pevsner (2002) Bioinformatics and Functional Genomics; Cold Spring Harbor Laboratory Press, Cold Spring Harbor, New York.

Immunology and Immunotechnology Lab COURSE CODE: 18MS7BT211 L-T-P: 0-0-2 Credits: 1	**Course Objectives** The objectives of this lab course are to develop an understanding about practical aspects of components of immune system as well as their function. Basic as well as advanced methods will be taught to detect different antigen and antibody interactions, isolation of different lymphocyte cells *etc.* and how they can be used in respective research work.	**Students Learning outcomes** **Students should be able** • Evaluate usefulness of immunology in different pharmaceutical companies; • Identify proper research lab working in area of their own interests; • Apply their knowledge and design immunological experiments to demonstrate innate, humoral or cytotoxic T lymphocyte responses and figure out kind of immune responses in setting of infection. (viral or bacterial) by looking at cytokine profile.

Syllabus:

1. To perform blood typing by agglutination.
2. To antigen detection by Dot ELISA method.
3. To quantify the concentration of unknown antigen by radial Immunodiffusion (RID).
4. To perform ouchterlony antigen for antibody titration.
5. To quantify the concentration of unknown antigen by rocket Immunoelectrophoresis.
6. To characterized the given antibody by Immunoelectrophoresis.
7. To quantify the amount of precipitation by Quantitative precipitation assay.
8. To determine the concentration of antigen by sandwich ELISA method.
9. To separate mononuclear cells from peripheral blood
10. To isolate the lymphocyte from whole blood by density gradient centrifugation method
11. To estimate the antibody titer using haemagglutination assay.
12. To determine Total Leukocytes Count (TLC) of the given blood sample.
13. To determine the relative number of white cells in the blood by performing differential cell counts
14. To perform Erythrocyte Rosette-forming Cell Test, ERFC

Recommended Textbooks and References:

1. Lab Manual of the Department of Biotechnology and Bioinformatics, JUIT,Waknaghat.

2. Hay FC and Westwood OMR (2003) Practical Immunology, 4th Ed., Blackwell Publishing. 3.

3. Virtual Lab. (http://vlab.amrita.edu/?sub=3&brch=70),
https://vlab.amrita.edu/?sub=3&brch=69)

Enzymes & Bioprocess Technology Lab **COURSE CODE: 20MS7MB271** **L-T-P: 0-0-2** Credits: 1	**Course Objectives** The objective of the course is to provide hands on training to students in bioprocess technology with the usage of microbials and enzymes. This course covers practical aspects of upstream processing and downstream unit operations with respect to current requirements of the manufacturing industries.	**Students Learning outcomes** **Students should be able** ▪ To investigate, design and conduct experiments, analyze and interpret data, and apply the laboratory skills to solve complex bioprocess technology problems; ▪ To learn how to operate bench scale bioreactor; ▪ To learn how to determine various Monod's Kinetics parameter; ▪ To learn how to determine various Michaelis Menten Kinetics parameter; ▪ To learn how to recover the various bioproduct after their production; ▪ To learn how to characterize the products after their recovery

Syllabus:

1. Describe the various parts of the bench-top fermenter (bioreactor) along with their functions.
2. Batch fermentation using shake-flask for ethanol production by *Saccharomyces cerevisae*.
3. To study growth kinetics parameters of *E. coli*.
    a) Specific growth rate (μ) h^{-1}
    b) Doubling time (t_d) h
    c) Maximum specific growth rate (μ_m) h^{-1}
    d) Saturation constant (K_s) gm/l
4. Setting up of a fermentation process for the production of extracellular industrial enzyme from the selected microbe of industrial importance
5. Determination of Growth yield coefficient ($Y_{x/s}$) and Productivity of biomass after setting of a fermentation

6. Downstream processing of the industrial enzyme produced by the fermentation process.
    a) Clarification
    b) Yield estimation
    c) Concentration using salt-induced precipitation
    d) Dialysis
    e) Purity check through SDS-PAGE and specific activity determination
7. Disruption of yeast cells using sonication to recover intracellular Invertase enzyme
8. Determination of protein and enzyme content in the cell lysate after the cell disruption
9. Determination of Michaelis Menten's kinetics parameters of purified amylase enzyme
10. Preparation of Immobilized yeast cells in calcium alginate beads
11. Characterization of immobilized yeast cells in terms of activity and stability
12. Preparation of Immobilized enzyme in calcium alginate beads
13. Characterization of immobilized enzyme in terms of activity and stability

Recommended Textbooks and References:

1) Lab Manual of the Department of Biotechnology and Bioinformatics, JUIT,Waknaghat.
2) M.L. Shuler and F. Kargi, "Bioprocess Engineering--basic Concepts", 2nd Edn. Prentice-hall Of India Pvt Ltd (2008).
3) Keith Wilson, John Walker, "Principles and Techniques of Biochemistry and Molecular Biology, 7th ed., Cambridge University Press, Singapore, 2010.
4) Raja Ghosh, "Principles of Bioseparation Engineering", World Scientific Publishing Co. Pte. Ltd., Singapore, 2006.
5) Pauline M. Doran, "Bioprocess Engineering Principles", 8th ed., Academic press, New York, 2003.
6) Peter F. Stanbury, Stephen J. Hall & A. Whitaker, "Principles of Fermentation Technology", Â Elsevier India Pvt Ltd. (2007).
7) Berg, J.M., Tymoczko, J.L. and Stryer, L., "*Biochemistry*", 5th ed., W.H. Freeman and Company, New York, 2002
8) Nelson D.L., Cox M.M., "Lehninger Principles of Biochemistry", 5th ed., W.H. Freeman and Company, New York, 2008.
9) Nicholas C. Price and Lewis Stevens, "Fundamental of Enzymology", Oxford University Press, Oxford. ISBN: 9780198502296.
10) Sawney S.K., Singh R. "Introductory Practical Biochemistry", Narosa Publisher, 2000. ISBN 9788173193026.

Machine Learning for Wireless Communication

COURSE CODE: 20B1WEC732

COURSE CREDITS: 3

CORE/ELECTIVE: Elective

L-T-P: 3-0-0

Pre-requisite: Basic knowledge of communication system

Course Objectives:

1. To understand the fundamentals of machine learning.
2. To understand the various technologies employed in wireless communication system.
3. Apply the machine learning in different field of engineering.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Able to understand the basics of machine learning	Familiarity
CO-2	Analyze the behavior of wireless channel	Assessment
CO-3	Able to understand various technology of wireless communication	Assessment
CO-4	Design and develop various machine learning algorithm in the field of wireless communication.	Usage

Course Contents:

Unit	Contents	Lectures required
1	ML overview, What is machine learning, How it works, Different types of Machine Learning, ML challenge, Supervised ML, Unsupervised learning, Deep reinforcement learning.	**8**
2	Data Scrubbing, Setting up Data, Regression Analysis, Clustering, Bias & Variance, Artificial Neural Networks, Decision Trees.	**8**
3	Overview of communication system, wireless channel fundamentals, Performance parameters of wireless channel.	**8**
4	Advanced Technology used in wireless communication**:** CRN, OFDM and MIMO	**10**
5	Application of Machine learning in recent technology of wireless communication, mini project work.	**8**
Total lectures		**42**

Suggested Text Book(s):

1. Wireless Communications – Principles and Practice; by Theodore S Rappaport, Pearson Education Pte. Ltd., Delhi
2. Andrea Goldsmith, "Wireless Communications," Cambridge University Press, 2005
3. Machine Learning for future wireless communication by Fa Long Lo

Suggested Reference Book(s):

1. Fundamentals of Wireless Communication by Tse David and Viswanath Pramod, Cambridge University press, Cambridge
2. Mobile Communications; By: Schiller, Jochen H; Addison Wesley Longman Pte Ltd., Delhi

3. Machine Learning Paradigms for Next-Generation Wireless Networks

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour	Syllabus covered up to T-1
2	T-2	25	1.5 Hours	Syllabus covered up to T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes(2) -10 Attendance - 5

Course Outcomes (COs) contribution to the Programmed Outcomes (POs)

Course outcomes (Machine Learning for Wireless Communication)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	1	2	2	2	3	1	1	1	1	2	2	3	**1.75**
CO-2	3	3	2	2	2	2	2	1	2	2	1	2	**2**
CO-3	3	1	2	1	2	2	2	2	2	3	1	1	**1.83**
CO-4	3	3	2	2	2	2	1	2	1	2	2	1	**1.91**
Average	**2.5**	**2.25**	**2**	**1.75**	**2.25**	**1.75**	**1.5**	**1.5**	**1.5**	**2.25**	**1.5**	**1.75**	

REMOTE SENSING AND GEOMATICS

COURSE CODE:

COURSE CREDITS: 3

CORE/ELECTIVE: OPEN ELECTIVE

L-T-P: 3-0-0

Pre-requisites: None

Course Outline:

With development of various hard and soft technologies in last two decades, advanced mapping techniques have evolved. It gives a paradigm shift as conventional surveys are superseded by advanced surveying techniques, which are not only accurate and flexible but require minimum time to acquire large amount of 3D data. Therefore, these techniques have been extensively used in many areas of engineering by students, researchers, and industries. On the other hand, the fundamental concepts of most of the advanced surveying techniques are not clear to all users. This course will introduce the students to the state-of-the-art concepts and practices of modern surveying, remote sensing and GIS. It starts with the fundamentals of surveying and remote sensing and GIS and subsequently advanced methods will be covered.

Course Objectives:

1. To familiarize students with the modern methods of collection and processing of topological data.
2. To introduce the students to the fundamentals of satellite-based surveying.
3. To enable the students to carry out detailed survey of any location using satellite data and advanced image processing techniques.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Understanding of the need and concepts of modern surveying	Understanding
CO-2	Application of Remote Sensing and GIS to collect topological data.	Application
CO-3	Analysis of satellite data using digital image processing to get details of topology	Analysis

Course Contents:

Unit	Contents	Lectures Required
1.	Introduction to Fundamentals of Basic Geomatics. (7 Lectures) Need and pre-requisites for Modern Surveying, Connection of Basic Surveying with Modern Surveying, Introduction to course content, and evaluation (1 lecture); Fundamental requirements of higher surveying: platform requirements, type of surveys, type of sensors, scanning mechanisms, scale and resolution of survey, planning of survey, data acquisition and data management (1 lecture); Coordinate systems in mapping for Earth surface (1 lecture).	**10**
2.	Coordinate and datum transformations for 3D coordinates on Earth surface (2 lecture);	**2**
3.	Introduction to Adjustments Computations, Methods of Adjustments Computations (1 Lecture) Accuracy assessment of parameters using Adjustments Computations (2 Lectures) Positioning and direction survey for navigation. Introduction to Photogrammetric survey (2Lectures)	**5**
4.	Introduction to basic concepts of remote sensing, Airborne and space borne sensors, Passive and active remote sensing (1 Lectures) EMR Spectrum, Energy sources and radiation principles, Energy interactions in the atmosphere (2 Lecture) Energy interactions with earth surface features, Spectral reflectance curves (1 Lectures)	**4**
5.	Satellites and orbits, Polar orbiting satellites, Spectral, radiometric and spatial resolutions, Temporal resolution of satellites (2 Lectures) Multispectral, thermal and hyperspectral sensing., Some remote sensing satellites and their features (1 Lecture)	**3**
6.	**Digital Image Processing – Image Restoration** Geometric corrections (1 Lecture) Co-registration of Data, Ground Control Points (GCP) (1 Lecture) Atmospheric corrections, Solar illumination corrections (1 Lecture)	**5**

	Digital Image Processing – Image Enhancement Concept of color, Color composites (1 Lecture) Contrast stretching – linear and non-linear stretching (1 Lecture)	
7.	**Digital Image Processing – Information Extraction** Multispectral classification, Ground truth collection (1 Lecture) Supervised and unsupervised classification (2 Lectures) **Digital Elevation Modeling** Introduction, Sources of digital elevation data, Types of DEM (1 Lecture) Radar interferometry, Shuttle Radar Topographic Mission (SRTM) data(2 Lectures)	**6**
8.	**Applications of Remote Sensing:** Watershed management (1 Lecture) Rainfall-runoff modeling (1 Lecture) Irrigation management (1 Lecture) Flood mapping (1 Lecture) Drought assessment (1 Lecture) Environmental monitoring (1 Lecture) Other applications (1 Lecture)	**7**
TOTAL		**42**

Suggested Textbook(s):

1. Burrough, P.A., and McDonnell, R.A.,'Principles of Geographical Information Systems', 2nd Edition, Oxford University Press, 1998.
2. Demers, M. N., Fundamentals of Geographic Information Systems, John Wiley & Sons, 3rd Edition, 2002.

Suggested Reference Book(s):

1. 'Remote Sensing and Image Interpretation', T.M. Lillesand and R.W. Kiefer, John Wiley & Sons, Singapore, 2002.
2. 'Introduction to Remote Sensing', J.B. Cambell, Taylor & Francis, UK, 2002.

3. 'Remote Sensing - Principles and Interpretation', F.F. Sabins Jr, W.H. Freeman & Co., New York, 1986.
4. 'Remote Sensing - Models and Methods for Image Processing', R.A. Schowengerdt, Elsevier India Pvt. Ltd., New Delhi, 2006.

Other useful resource(s):

Link to NPTEL courses:

1. https://nptel.ac.in/courses/105/103/105103176/
2. https://nptel.ac.in/courses/105/104/105104100/
3. https://nptel.ac.in/courses/105/101/105101206/
4. https://nptel.ac.in/courses/121/107/121107009/
5. https://nptel.ac.in/courses/105/103/105103193/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1.	T-1	15	1 Hour.	Syllabus covered upto T-1
2.	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Throughout the Semester	Assignment (4) – 10 Quizzes (2)-10 (Best Score) Attendance - 5

Course Outcomes (COs) contribution to the Program Outcomes (POs)

Course Outcomes	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	1	1	2	2	3	1	1	1	2	2	1	2	1.583
CO-2	2	2	2	2	3	2	1	1	2	1	1	2	1.75
CO-3	2	3	3	3	3	2	1	1	2	2	1	2	2.083
Average	1.667	2	2.333	2.333	3	1.667	1	1	2	1.667	1	2	

Renewable Energy Systems

COURSE CODE: 21B1WEC732

COURSE CREDITS: 3

CORE/ELECTIVE: Open Elective

L-T-P: 3-0-0

Pre-requisite:- Renewable Energy Systems

Course Objectives:

1. To study the non conventional energy systems, resources and performance parameters.
2. Technology included will be Solar, Wind, Hydro, Batteries and Fuel Cells etc.

Course Outcomes:

Sr. No.	Course Outcomes	Level of Attainment
CO-1	Quantities of Energy , Sources of Energy	Familiarity
CO-2	Solar energy, Solar Radiation, Solar Spectrum, Solar technologies	Familiarity
CO-3	Solar Photovoltaic Devices, Performance and Durability of Solar Devices.	Usage
CO-4	Wind Energy and Technological Aspects, Batteries and Fuel Cells.	Assessment

Course Contents:

Unit	Contents	Lectures
1	**Introduction:** Renewable Energy Technologies, Conventional Sources of Energy. Energy Consumption and Energy Sector. Environmental consequences of oil fuel use, Importance of renewable sources of energy, Sustainable Design and development, Types of RE sources, Limitations of RE sources, Present Indian and International energy scenario of conventional and RE sources.	8
2	**Solar Energy and Thermal Systems:** Solar Energy Incident on Earth ,Solar radiation measurement Solar Spectrum, Solar Budget, Solar Plate Reflector, Solar Radiator, Basics of Semiconductor, PN –Junction Diode, Solar Cell Constructions, characteristic and Usage.	10

	Solar Photovoltaic systems: Basic Principle of SPV conversion – Types of PV Systems- Types of Solar Cells. Photovoltaic cell concepts: Cell, module, PV Module I-V Characteristics, Efficiency & Quality of the Cell, series and parallel connections, maximum power point tracking.	
3	**Wind Energy**: Basics and concepts, Efficiency, Parts and design. Characteristics and power generation from Wind Energy.	8
4	**Batteries**: Battery basics, testing and performance Li-ion Batteries, Common Battery Structures and types.	9
5	**Fuel Cell**: Types of Fuel Cell, Fuel Processing for PEM Fuel cells Fuel cell concept to product, Fuel Cell parts and assembly, characteristics and Durability. Supercapacitors.	7
Total lectures		42

Suggested Text Book(s):

1. Renewable Energy- Edited by Godfrey Boyle-oxford university, press, 3rd edition, 2013.
2. Handbook of renewable technology Ahmed and Zobaa, Ramesh C Bansal, World scientific, Singapore.
3. Solar Energy: Principles of Thermal Collection and Storage, S. P. Sukhatme and J. K. Nayak, TMH, New Delhi, 3rd Edition.
4. Renewable Energy Resources, John Twidell and Tony Weir, Taylor and Francis - second edition, 2013.
5. Non-Conventional Energy Sources /G.D. Rai, Khanna Publishers.

Suggested Reference Book(s):

1. Non conventional energy source –B.H. Khan- TMH-2nd edition.
2. Integrated energy systems modeling--Karlsson, Kenneth Bernard; Skytte, Klaus Morthorst;Publishedin:DTU International Energy Report 2015

Other Useful Online Resources:

1. https://nptel.ac.in/courses/121/106/121106014/
2. https://nptel.ac.in/courses/103/103/103103206/
3. https://nptel.ac.in/courses/108/108/108108078/

Evaluation Scheme

Sr. No	Exam	Marks	Duration	Coverage/ Scope of Examination.
1	T-1	15	1 Hour	Syllabus covered up to T-1
2	T-2	25	1.5 Hours	Syllabus covered up to T-2

3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) – 10 Quizzes (2) – 10 Attendance (5)

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Design and Analysis of Algorithms)	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**Average**
CO-1	3	3	3	3	3	1	1	3	3	3	1	3	**2.5**
CO-2	2	2	2	2	2	1	1	1	2	1	1	2	**1.6**
CO-3	3	3	3	3	3	1	1	1	3	1	1	3	**2.2**
CO-4	2	2	2	2	2	2	1	1	2	1	2	2	**1.8**
Average	**2.5**	**2.5**	**2.5**	**2.5**	**2.5**	**1.25**	**1**	**1.5**	**2.5**	**1.5**	**2.4**	**2.4**	

Signal Processing for Machine Learning

COURSE CODE: 20B1WEC733

COURSE CREDITS: 3

CORE/ELECTIVE: Open Elective

L-T-P: 3-0-0

Pre-requisite: Engineering Mathematics, MATLAB Programming/Python Programming/R programming,

Course Objectives:

1. This course is intended to teach the students of CSE/IT/ECE. This course is a blend of signal processing and machine learning.
2. It will provide the ability to students to understand the role of signal processing methods for machine learning.
3. To provide the knowledge of de-noising, feature extraction techniques for machine learning techniques.

Course Outcomes:

Course Outcomes ()		**Level of Attainment**
CO-1	Student will be familiar with the different type signal processing	Familiarity
CO-2	Student will able to understand the pre-processing and de-noising techniques	Assessment
CO-3	Student will able to understand the feature extraction techniques	Assessment
CO-4	Student will able to understand the machine learning techniques	Assessment
CO-5	Student will able to apply the signal processing and machine learning techniques for different applications.	Usage

Course Contents:

S. No.	**Contents**	**Contact Hours**
1	**Introduction of the signal processing.** 1-D signal processing: Analog signal processing, digital signal processing , statistical signal processing, acoustic signal processing, speech processing, bio-signal processing, genomics signal processing, multimedia signal processing, VLSI signal processing, Radar signal processing, and Music signal processing,2-D signal processing: image processing, and 3-D signal processing: video signal processing.	06
2	**Signal preprocessing/de-noising techniques** Filters, transforms, and filter banks	08
3	**Feature extraction techniques** DFT, DWT, CWT, STFT, WVD, and other spectral methods.	08
4	**Machine learning Techniques** Introduction to supervised, unsupervised, reinforcement learning, learning rule,	10

	and activation functions, artificial neural network, support vector machine.	
5.	**Applications** Hands on practice of the signal processing and machine learning based applications in genomics data analysis, respiratory sound analysis, vibration signal analysis, classification of disease signals, and image classification, etc.	10
	Total	**42**

Suggested Text Book(s):

1. J. G. Proakis and D. G. Manolakis, "Digital Signal Processing", 4th Edition, Prentice Hall, 2007.

2. S.N. Sivanandam, S.N Deepa, "Principles of Soft Computing", 3rd Edition, Wiley, 2019.

3. Sejdic, E. and Falk, "Signal Processing and Machine Learning for Biomedical Big Data". CRC Press,2018.

Suggested Reference Book(s):

1. Advanced Machine Learning and Signal Processing, is part of the IBM Advanced Data Science Specialization

https://www.coursera.org/learn/advanced-machine-learning-signal-processing#syllabus

2. Machine learning for signal processing

http://home.iitk.ac.in/~vipular/stuff/2019_MLSP.html

3. Deep learning for signal processing

https://www.kdnuggets.com/2020/07/deep-learning-signal-processing.html

Other useful resource(s):

1. **Evaluation Scheme:**

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered up to T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes(2) -10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

COs/POs	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average

CO-1	3	3	2	2	2	3	3	2	3	3	3	3	2.666667
CO-2	3	3	3	3	3	3	3	3	3	3	3	3	3
CO-3	3	3	3	3	3	2	3	3	2	3	3	3	2.833333
CO-4	3	3	3	3	3	3	2	3	3	3	3	3	2.916667
Average	3	3	2.75	2.75	2.75	2.75	2.75	2.75	2.75	3	3	3	

DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

Master of Technology in Electronics & Communication with specialization in Internet of Things

Effective from Academic Session – 2021-22

Detailed Course Structure & Curriculum

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY

Approved in Academic Council Meeting held on 28 July, 2021

SEMESTER - I								
S. No.	**Course Code**	**Name of the Subjects**		**Course Hours**			**Total**	**Credits**
			C/E	**L**	**T**	**P**		
1	21M11EC112	Embedded Systems and Applications	C	3	0	0	3	3
2	21M11EC111	Sensor and Smart Instrumentation	C	3	0	0	3	3
3	21M11EC113	Object Oriented Programming	C	3	0	0	3	3
4		Departmental Elective - I	E	3	0	0	3	3
5		Departmental Elective - II	E	3	0	0	3	3
6		Departmental Elective - III	E	3	0	0	3	3
7	21M11EC171	Advanced IoT Lab - I	C	0	0	6	6	3
						Total	**24**	**21**
SEMESTER - II								
S.No.	**Course Code**	**Subject Names**		**Course Hours**			**Total**	**Credits**
			C/E	**L**	**T**	**P**		
1	21M11EC211	Digital System design using verilog HDL	C	3	0	0	3	3
2	21M11EC212	Artificial Intelligence and Expert Systems	C	3	0	0	3	3
3	21M11EC213	Network Security Protocols	C	3	0	0	3	3
4		Departmental Elective - IV	E	3	0	0	3	3
5		Departmental Elective - V	E	3	0	0	3	3
6		Open Elective	E	3	0	0	3	3
7	21M11EC271	Advanced IoT Lab - II	C	0	0	6	6	3
						Total	**24**	**21**
SEMESTER - III								
S. No.	**Course Code**	**Name of the Subjects**		**Course Hours**			**Total**	**Credits**
			C/E	**L**	**T**	**P**		
1	21M19EC391	Literature Review / Seminar	C	0	0	6	6	3
2	21M19EC392	Dissertation Part - I	C	0	0	28	28	14
						Total	**34**	**17**
SEMESTER - IV								
S.No.	**Course Code**	**Subject Names**		**Course Hours**			**Total**	**Credits**
			C/E	**L**	**T**	**P**		
1	21M19EC491	Seminar	C	0	0	6	6	3
2	21M19EC492	Dissertation Part - II	C	0	0	28	28	14
						Total	**34**	**17**

LIST OF ELECTIVES								
ELECTIVE - I								
S.No.	**Course Code**	**Subject Names**		**Course Hours**			**Total**	**Credits**
			C/E	**L**	**T**	**P**		
1	21M1WEC132	IoT Architecture and Protocols	E	3	0	0	3	3
2	21M1WEC131	Wireless Technologies for IoT	E	3	0	0	3	3
ELECTIVE – II								
S.No.	**Course Code**	**Subject Names**		**Course Hours**			**Total**	**Credits**
			C/E	**L**	**T**	**P**		
1	21M1WEC133	Industrial Automation and IIoT	E	3	0	0	3	3
2	21M1WEC134	Intelligent Robotics and Shared Autonomy	E	3	0	0	3	3
ELECTIVE – III								
S.No.	**Course Code**	**Subject Names**		**Course Hours**			**Total**	**Credits**
			C/E	**L**	**T**	**P**		
1	21M1WEC135	Signal Processing for IoT	E	3	0	0	3	3
2	21M1WEC136	Intelligent signal Processing	E	3	0	0	3	3
ELECTIVE – IV								
S.No.	**Course Code**	**Subject Names**		**Course Hours**			**Total**	**Credits**
			C/E	**L**	**T**	**P**		
1	21M1WEC231	Image Sensing and Realtime Processing	E	3	0	0	3	3
2	21M1WEC232	Medical Image Processing and Applications	E	3	0	0	3	3
3	21M1WEC233	Applied Machine Learning for IoT	E	3	0	0	3	3
ELECTIVE – V								
S.No.	**Course Code**	**Subject Names**		**Course Hours**			**Total**	**Credits**
			C/E	**L**	**T**	**P**		
1	21M1WEC234	Antennas for IoT	E	3	0	0	3	3
2	21M1WEC235	RF technology for 5G and IoT	E	3	0	0	3	3
3	21M1WEC236	Smart Internet of Things	E	3	0	0	3	3

M. TECH.

ELECTRONICS & COMMUNICATION

ENGINEERING WITH SPECIALIZATION IN INTERNET OF THINGS (IoT)

COURSE CONTENTS

Approved in Academic Council Meeting held on 28 July, 2021

Embedded Systems and Applications

COURSE CODE: 21M11EC112

COURSE CREDITS: 3

CORE/ELECTIVE: CORE

L-T-P: 3-0-0

Prerequisite: None

Course Objectives:

To learn about the embedded system application areas, design challenges, embedded system processors and tools used for embedded system design.

Course Outcomes:

Sl. No.	Course Outcomes	Level of Attainment
1	Understand various components of embedded system, design challenges	Familiarity
2	Comprehend RISC architecture, programming of ARM and PIC microcontrollers	Usage
3	Know about embedded system design and development methodology, tools and languages used for embedded system design	Usage
4	Learn about Devices and Communication interface used in embedded system	Usage
5	Learn about Real Time Operating System used for embedded system application	Usage

Course Contents:

Unit	Contents	Lectures required
1	Introduction: Characteristics of Embedded System Computing, Concept of Real time Systems, Classification, Application areas, Design challenges – real-time execution, physical size, power consumption, multirate operation	6
2	Embedded system processors: ARM Processor Fundamentals and Architectures, ARM Instruction Set, PIC Microcontroller and its Architecture, Instruction Set	8
3	Embedded hardware units and devices in a System, Embedded software in a system, Embedded system-on-chip (SOC), Embedded system-on-module (SOM)	6
4	Devices and Communication interface: Serial communication devices, Parallel communication, Wireless Devices, Timer and Counting Devices, Watchdog timer, Real time clock, Parallel communication network using ISA, PCI, Serial bus communication protocols, SCI, CAN, I2C, USB	8
5	Real Time Operating System: Real-time Kernels, Polled Loops System, Co-routines, Interrupt-driven System, Multi-rate System, Processes and Threads,	8

	Context Switching, Scheduling, Inter-process Communication, Real-time Memory Management, I/O, VxWorks, RT-Linux	
6	Case Study: ARM Cortex-A5 Processor-based SOM, ATSAMA5D27-SOM1, Use of SAMA5D2 GPIO under Linux	6
Total lectures		**42**

Suggested Text Book(s):

1. Frank Vahid and Tony Givargis, "Embedded system design: A unified Hardware/Software introduction,"3rd Ed., Wiley 2014

2. Shibu K. V, "Introduction to Embedded Systems," 2nd Ed., McGraw Hill 2017

3. Embedded System: Architecture, Programming and Design by Rajkamal,2nd Ed., 2010, Tata McGraw Hill

Suggested Reference Book(s):

1. Steve Furber, "ARM System-on-Chip Architecture," 2nd Ed., Pearson, 2012

2. Tim Wilmshurst, "Designing Embedded Systems with PIC Microcontrollers: Principles and Applications," 2nd Ed., Newnes, 2009

3. Steven F Barrett and Daniel J Pack, "Embedded Systems Design and Applications with the 68HC12 and HCS12," 1st Ed., Pearson 2012

4. Kenneth Ayala, "The 8051 microcontroller," 3rd Ed., Thomson,2005

Other useful resource(s):

https://www.microchip.com/wwwproducts/en/ATSAMA5D27-SOM1

https://www.microchip.com/wwwappnotes/appnotes.aspx?appnote=en1000789

NPTEL ONLINE COURSES

1. Embedded Systems: https://nptel.ac.in/courses/108105057/
2. Embedded Systems: https://nptel.ac.in/courses/108102045/
3. Embedded Systems Design: https://nptel.ac.in/courses/106105159/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered up to T-1
2	T-2	25	1.5 Hours	Syllabus covered up to T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Sensors and Smart Instrumentation

COURSE CODE:21M11EC111

COURSE CREDITS: 3

CORE/ELECTIVE: CORE

L-T-P: 3-0-0

Prerequisite: None

Course Objectives:

To learn about various sensors and transducers and their integration in a smart instrumentation system

Course Outcomes:

Sl. No.	Course Outcomes	Level of Attainment
1	Knowledge of characteristics of sensors and measurement system, criteria for transducer selection	Familiarity
2	Learn about data acquisition systems, signal conditioners and signal converters	Usage
3	Knowledge about different basic sensors and transducers used for measurement of physical quantities	Usage
4	Knowledge about different measurement systems used in industry	Usage
5	Learn about characteristics and working of smart sensors and instruments	Assessment

Course Contents:

Unit	Contents	Lectures required
1	Introduction: Basics of measurement systems, sensors and transducers, General transducers characteristics, static and dynamic characteristics, Criteria for transducer selection, Calibration techniques, Classification of errors	6
2	Data acquisition system and its uses in intelligent Instrumentation systems, Signal conditioners, signal converters, sample and hold. Instrumentation amplifiers, Interference, grounding and shielding	8
3	Resistive Transducers: Potentiometers, strain gauges, Resistance Thermometer, Thermistors. Inductive Transducers, Capacitive Transducers: Principles of operation, construction, Piezoelectric transducer, fibre optic transducers for the measurement of force, temperature, flow and pressure, Elastic Transducers: Spring bellows, diaphragm, bourdon tube.	10

4	Pressure sensor, temperature measurement, flow measurement, level measurement, displacement, force, velocity, acceleration and torque measurement. Telemetry, multiplexing, modulation of data, transmission channels.	8
5	Smart instruments - comparison with conventional transducers - self diagnosis and remote calibration features - smart transmitter with HART communicator - Micro Electro Mechanical Systems - sensors, actuators - principles and applications, nonlinearity compensation. Cogent sensors, Soft sensors, self-validating sensors, temperature-compensating sensors, ANN-based sensors, ANN techniques for fault detection, linearization, and calibration	10
Total lectures		**42**

Suggested Text Book(s):

1. Doebelin EO, "Measurement Systems: Application and Design," Tata McGraw Hill, 7th Ed., 2019
2. Patranabis D, "Sensors and Transducers," Prentice Hall of India, 2nd Ed., 2003
3. Manabendra Bhuyan, "Intelligent Instrumentation: Principles and Applications", CRC Press, 2017

Suggested Reference Book(s):

1. Subhas Chandra Mukhopadhyay, "Intelligent Sensing, Instrumentation and Measurements (Smart Sensors, Measurement and Instrumentation Book 5)," Springer, 2013.
2. Bela G. Liptak, "Instrument Engineers' Handbook, Volume One: Process Measurement and Analysis," 4th Ed., CRC Press, 2003

Other useful resource(s):

NPTEL Course: https://nptel.ac.in/courses/108/105/108105064/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1.	T-1	15	1 Hour.	Syllabus covered up to T-1
2.	T-2	25	1.5 Hours	Syllabus covered up to T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Object Oriented Programming

COURSE CODE: 21M11EC113

COURSE CREDITS: 3

CORE/ELECTIVE: CORE

L-T-P: 3-0-0

Prerequisite: None Course Objectives:

To learn the concept of object oriented programming and to acquire programming skills in Python, C++ and JAVA

Course Outcomes:

object oriented

Sl. No.	Course Outcomes	Level of Attainment
1	Learn about object-oriented approach to programming and advantages of Object-oriented programming over other approaches	Familiarity
2	Understand the concepts of data abstraction, encapsulation, inheritance and polymorphism	Familiarity
3	Analyze and decompose problem specifications from Object Oriented Perspectives and represent the solution, using UML notation	Usage
4	Learn to do object oriented programming using Python	Usage
5	Learn to do object oriented programming using C++ and JAVA	Usage

Course Contents:

Unit	Contents	Lectures required
1	Introduction: procedural programming, structured programming, abstract data types, data encapsulation, object oriented programming paradigm	6
2	Abstract Data Types, Classes and Objects, Inheritance (Single, Multilevel, Multiple, Hierarchical, Hybrid). Super-classes (base classes) and sub-classes (derived classes). Specialisation vs. Generalisation. Abstract and Concrete Classes and Methods. Inheritance for Specialisation vs. Specification. Inter-class Relationships (isa, has-a, part-of, association, aggregation, composition). Class members: fields (data members, variables, attributes), and methods (member functions, procedures). Messages. Object State. Constructors (parameterised, copy, conversion, default) and destructors. Object and member scope. Polymorphism.	10

3	Unified Modelling Language (UML). Use case diagrams: actors, system boundary, <<uses>> and <<extends>>. Class diagrams: associations, aggregation, dependency, and inheritance. Object interaction diagrams, object state transition diagrams.	8
4	Object oriented programming using Python: Builtin classes in Python - data types. User defined class, Object, Method, Inheritance, Encapsulation, Polymorphism, Data Abstraction in Python. Exception handling.	8
5	Object oriented programming using C++ and JAVA: Objects, Classes, Methods, Constructors and destructors. Friend Functions, Static member functions, Inheritance, Multiple Inheritance, Polymorphism and Virtual Functions, Function and Operator overloading, Namespace and Templates in C++. Packages, Class path, Interfaces in JAVA. Exception Handling in C++ and JAVA	10
Total lectures		**42**

Suggested Text Book(s):

1. Robert Lafore, "Object-Oriented Programming in C++," 4th Ed., Sams, 2001
2. Herbert Schildt, "Java The Complete Reference - 11th Ed. McGraw Hill, 2020
3. Martin C. Brown, "Python: The Complete Reference", 4th Ed. McGraw Hill, 2018

Suggested Reference Book(s):

1. A Downey, "Learning with Python", Dreamtech Press, 2015
2. Bjarne Stroustrup, "The C++ Programming Language," 3rd Ed., Pearson, 2002
3. Matha, "Object - Oriented Analysis and Design Using UML: Introduction to Unified Process and Design Patterns", PHI, 2008

Other useful resource(s):

NPTEL Course: https://nptel.ac.in/courses/106/105/106105153/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1.	T-1	15	1 Hour.	Syllabus covered up to T-1
2.	T-2	25	1.5 Hours	Syllabus covered up to T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Approved in Academic Council Meeting held on 28 July, 2021

IoT Architecture and Protocols

COURSE CODE: 21M1WEC132

COURSE CREDITS: 3
CORE/ELECTIVE:
Elective L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

1. Understand the concepts of IoT Architecture Reference model.
2. Understand the different protocols employed for IoT.
3. Design IoT-based systems for real-world problems.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Comprehend the essentials of IoT and its applications	Familiarity
CO-2	Understand the concepts of IoT Architecture Reference model	Assessment
CO-3	Analyze various IoT Application layer Protocols.	Assessment
CO-4	Apply IP based protocols and Authentication Protocols for IoT	Usage
CO-5	Design IoT-based systems for real-world problems	Usage

Course Contents:

Unit	Contents	Lectures required
1	**Introduction to IOT, Applications of IOT, Use cases of IOT** Introduction- The IOT Today & Progression to Tomorrow – Success Factors –Strategic Research & Innovation Directions.	7
2	IOT and Related Issues - IOT & Related Future Internet Technologies – Networks & Communication – Processes & Data Management - Security, Privacy & Trust - Protocol Convergence	7
3	An Architectural Overview, Reference Model and IOT Architecture - Architecture Reference Model – IOT Reference Architecture: Architecture, Functional, information, deployment and operation views; SOA based Architecture, API-based Architecture, OPEN IoT Architecture for IoT/Cloud Convergence.	10

4	IOT Smart Applications, Cloud Service Management and IOT - Connecting IOT to cloud – Cloud Storage for Iot – Data Analytics for IoT – Software & Management Tools for IOT. Application Protocols for IoT: UPnP, CoAP, MQTT, XMPP. SCADA, Web Socket; IP-based protocols: 6LoWPAN, RPL; Authentication Protocols; IEEE 802.15.4.	**10**
5	Case study 1: M2M To IOT -M2M Vs IOT – A vision from M2M to IOT – Case Study 2: Cloud-Based Smart-Facilities Management, Healthcare, Environment Monitoring System.	**8**
Total lectures		**42**

Suggested Text Book(s):

1. Ovidiu Vermesan, Peter Friess, "Internet of Things – From Research & Innovation to Market Deployment", River Publishers, 2014
2. Jan Holler ,VlasiosTsiatsis, Catherine Mulligan, Stamatis Karnouskos, Stefan Avesand, David Boyle, "From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence", Elsevier Ltd, 2014.
3. Bassi, Alessandro, et al, "Enabling things to talk", Springer-Verlag Berlin An, 2016.
4. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry, "IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things", CISCO Press, 2017

Suggested Reference Book(s):

1. Arshdeep Bahga, Vijay Madisetti, "Internet of Things – A hands-on approach", Universities Press, 2015.
2. Manoel Carlos Ramon, "Intel® Galileo and Intel® Galileo Gen 2: API Features and Arduino Projects for Linux Programmers", Apress, 2014.
3. Hersent, Olivier, David Boswarthick, and Omar Elloumi. The internet of things: Key applications and protocols. John Wiley & Sons, 2011.
4. Buyya, Rajkumar, and Amir Vahid Dastjerdi, eds. Internet of Things: Principles and paradigms. Elsevier, 2016.

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programmed Outcomes (POs)

Course outcomes (IoT Architecture and Protocols)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	1	2	2	2	3	1	1	1	1	2	2	3	**1.75**
CO-2	3	3	2	2	2	2	2	1	2	2	1	2	**2**
CO-3	3	1	2	1	2	2	2	2	2	3	1	1	**1.83**
CO-4	3	3	2	2	2	2	1	2	1	2	2	1	**1.91**
Average	**2.5**	**2.25**	**2**	**1.75**	**2.25**	**1.75**	**1.5**	**1.5**	**1.5**	**2.25**	**1.5**	**1.75**	

Wireless Technologies for IoT

COURSE CODE:21MIWEC131

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

1. To understand the fundamentals of wireless networks.
2. Analyze the standards of IoT which employed for wireless networks.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	To understand the fundamentals of wireless networks	Familiarity
CO-2	Analyze the standards of IoT which employed for wireless networks	Assessment
CO-3	Explain the use of various wireless technologies in IoT	Assessment
CO-4	Design and develop various applications of IoT	Usage

Course Contents:

Unit	Contents	Lectures required
1	**Cellular Standards:** Cellular carriers and Frequencies, Channel allocation, Cell coverage, Cell Splitting, Microcells, Picocells, Handoff, 1st, 2nd, 3rd and 4th Generation Cellular Systems (GSM, CDMA, GPRS, EDGE,UMTS), Mobile IP, WCDMA	8
2	**RF Basics: Radio Frequency (RF) Fundamentals:** Introduction to RF & Wireless Communications Systems, RF and Microwave Spectral Analysis, Communication Standards, Understanding RF & Microwave Specifications. Spectrum Analysis of RF Environment, Protocol Analysis of RF Environment, Units of RF measurements, Factors affecting network range and speed, Environment, Line-of-sight, Interference, Defining differences between physical layers- OFDM.	9

3	**WLAN: Wi-Fi Organizations and Standards:** IEEE, Wi-Fi Alliance, WLAN Connectivity, WLAN QoS & Power-Save, IEEE 802.11 Standards,802.11- 2007,802.11a/b/g, 802.11e/h/I,802.11n	**8**
4	**Wi-Fi Hardware & Software:** Access Points, WLAN Routers, WLAN Bridges, WLAN Repeaters, Direct-connect Aps, Distributed connect Aps, PoE Infrastructure, Endpoint, Client hardware and software, Wi-Fi Applications	**9**
5	**WSN & WPN:** Wireless Personal Area Networks, Bluetooth, Bluetooth Standards, BlueTooth Protocol Architecture, UWB, IEEE 802.15 standards, ZigBee, Sub1GHz, Sensor Networks, coexistence strategies in Sensor Networks, Routing protocols in Wireless Sensor Networks.	**8**
Total lectures		**42**

Suggested Text Book(s):

1. Wireless Communications – Principles and Practice; by Theodore S Rappaport, Pearson Education Pte. Ltd., Delhi
2. Wireless Communications and Networking; By: Stallings, William; Pearson Education Pte. Ltd., Delhi
3. Bluetooth Revealed; By: Miller, Brent A, Bisdikian, Chatschik; Addison Wesley Longman Pte Ltd., Delhi
4. Wilson , "Sensor Technology hand book," Elsevier publications 2005.
5. Andrea Goldsmith, "Wireless Communications," Cambridge University Press, 2005

Suggested Reference Book(s):

1. Mobile and Personal Communications Services and Systems; 1st Edition; By: Raj Pandya; PHI, New Delhi
2. Fundamentals of Wireless Communication by Tse David and Viswanath Pramod, Cambridge University press, Cambridge
3. Mobile Communications; By: Schiller, Jochen H; Addison Wesley Longman Pte Ltd., Delhi
4. 3G Networks: Architecture, protocols and procedures based on 3GPP specifications for UMTS WCDMA networks, By Kasera, Sumit, Narang, and Nishit, TATA MGH, New Delhi
5. Wireless Sensor Networks: information processing by approach, ZHAO, FENG, GUIBAS and LEONIDAS J, ELSEVIER, New Delhi

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programmed Outcomes (POs)

Course outcomes (Wireless Technologies for IoT)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	1	2	2	2	3	1	1	1	1	2	2	3	**1.75**
CO-2	3	3	2	2	2	2	2	1	2	2	1	2	**2**
CO-3	3	1	2	1	2	2	2	2	2	3	1	1	**1.83**
CO-4	3	3	2	2	2	2	1	2	1	2	2	1	**1.91**
Average	**2.5**	**2.25**	**2**	**1.75**	**2.25**	**1.75**	**1.5**	**1.5**	**1.5**	**2.25**	**1.5**	**1.75**	

Industrial Automation and IIoT

COURSE CODE: 21M1WEC133

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Prerequisite: None

Course Objectives:

To learn about industrial automation, and Industrial Internet of Things (IIoT) which is an application of IoT in industries to modify the various existing industrial systems.

Course Outcomes:

Sl. No.	Course Outcomes	Level of Attainment
1	Learn about history, architecture and advantages of Industrial automation	Familiarity
2	Knowledge about various components used for Industrial automation	Familiarity
3	Learn about PLC, SCADA and DCS used for automation	Usage
4	Study about Industrial Communication and Human Machine Interface	Assessment
5	Learn about Industrial IoT reference architecture, layers and application domains	Assessment

Course Contents:

Unit	Contents	Lectures required
1	Introduction: History of automation, Automation systems, Types of automation, Automation overview, Requirement of automation systems, Architecture of Industrial Automation system, Advantages and limitations of Automation, Industrial revolutions.	6
2	Automation components: Sensors and actuators, Electric, Hydraulic, Pneumatic, actuators, process control valves, Introduction of DC and AC servo drives for motion control. Controllers, Transmitters and Signal Conditioning: Need of transmitters, Standardization of signals, Current, Voltage and Pneumatic signal standards, 2-Wire & 3-Wire transmitters, Analog and Digital signal conditioning for sensors, Smart and Intelligent transmitters	8
3	Programmable logic controllers: Programmable controllers, Programmable logic controllers, Analog digital input and output modules, PLC programming, Ladder diagram, Sequential flow chart, PLC Communication and networking, PLC selection, PLC Installation, Advantage of using PLC for Industrial automation, Application of PLC to process control industries.	6
	SCADA & Distributed control system: Elements of SCADA, Features of SCADA,	

4	MTU, RTU Functions, Applications of SCADA, Communications in SCADA, Introduction to DCS, Architecture, Input and output modules, Specifications of DCS.	6
5	Industrial Communication and Human Machine Interface (HMI): Device network: CAN, PROFIBUS-PA, Control network: ControlNet, PROFIBUS-DP, Ethernet, Interfaces: RFID, Barcode, HMI: Block Diagram, Types, Advantages and industrial applications.	8
6	Industrial IoT: Business Model and Reference Architecture, Layers: IIoT Sensing, IIoT Processing, IIoT Communication , IIoT Networking. Industrial IoT-Application Domains: Healthcare, Power Plants, Inventory Management & Quality Control, Plant Safety and Security, Oil, chemical and pharmaceutical industry.	8
Total lectures		42

Suggested Text Book(s):

1. K. S. Singh, "Industrial Instrumentation and Control", 3rd Ed., The McGraw Hill, 2010
2. C.D. Johnson, "Process Control Instrumentation Technology", 8th Ed., PHI, 2015
3. Madhuchhanda Mitra, SamarjitSen Gupta, "Programmable Logic controllers and Industrial Automation", Penram International, 2008

Suggested Reference Book(s):

1. Gregory K. McMillan, P. Hunter Vegas, "Process / Industrial Instruments and Controls Handbook," 6th Ed., McGraw Hill, 2019
2. Bela G. Liptak, Kriszta Venczel, "Instrument and Automation Engineers' Handbook: Process Measurement and Analysis," 5th Ed., CRC Press, 2016
3. A. Suresh et. al., "Industrial IoT Application Architectures and Use Cases", 1st Ed., CRC Press, 2018
4. Giacomo Veneri Antonio Capasso, "Hands-On Industrial Internet of Things: Create a powerful Industrial IoT infrastructure using Industry 4.0", Ingram short title, 2018.

Other useful resource(s):

NPTEL Course:

https://nptel.ac.in/courses/108/105/108105088/

https://nptel.ac.in/courses/108/105/108105063/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1.	T-1	15	1 Hour.	Syllabus covered up to T-1

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2.	T-2	25	1.5 Hours	Syllabus covered up to T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Intelligent Robotics and Shared Autonomy

COURSE CODE: 21M1WEC134

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Prerequisite: None

Course Objectives:

To learn about robotics, various elements, kinematics, dynamics and motion control of a robot and to get acquainted with intelligent robots working on shared autonomy.

Course Outcomes:

Sl. No.	Course Outcomes	Level of Attainment
1	Learn about history, classification and application of robots	Familiarity
2	Learn about elements of a robot, D-H parameters and homogeneous transformation	Usage
3	Knowledge about sensors and actuators used in robots	Assessment
4	Learn about robot kinematics, dynamics, motion planning and control	Usage
5	Study about intelligent robots and robot working on shared autonomy	Usage

Course Contents:

Unit	Contents	Lectures required
1	Introduction to Robotics: Introduction – brief history, types, classification and usage	4
2	Elements of Robots - joints, links, actuators, and sensors: Position and orientation of a rigid body, Homogeneous transformations, Representation of joints, link representation using D-H parameters, Examples of D-H parameters and link transforms	8
3	Actuators – stepper, DC servo and brushless motors, model of a DC servo motor, Types of transmissions, Purpose of sensors, internal and external sensors, common	8

	sensors – encoders, tachometers, strain gauge based force- torque sensors, proximity and distance measuring sensors, and vision.	
4	Robot Arm Kinematics and Dynamics: forward kinematics, Inverse kinematics, Lagrange formulation of dynamics	6
5	Motion Planning and Control: Joint and Cartesian space trajectory planning and generation, Classical control concepts using the example of control of a single link, Independent joint PID control, Control of a multi-link manipulator	8
6	Probability Based Approaches, Markov Decision Processes (MDPs), Partially Observable Markov Decision Processes, Navigation, Behaviour-Based Control. Adaptive approaches to robot control, Reinforcement learning for control, Model Based learning approaches to control, Evolutionary approaches, Interaction-aware control, intent inference, and shared autonomy	8
Total lectures		42

Suggested Text Book(s):

1. J. J. Craig, "Introduction to Robotics- Mechanics and Control", Pearson, 3rd Edition, 2009.
2. Spong and Vidyasagar, "Robot Dynamics and Control", Wiley Student Edition, John Wiley and Sons, 2013.
3. Roland Siegwart, "Introduction to Autonomous Mobile Robots," 2nd Ed. (Intelligent Robotics and Autonomous Agents series) MIT Press, 2011

Suggested Reference Book(s):

1. Sciavicco and Siciliano, "Modeling and Control of Robot Manipulators", Springer, 2nd Edition, 2002.
2. D.K. Pratihar, "Fundamentals of Robotics", Narosa Publishing House, 1st Edition, 2017.

Other useful resource(s):

1. Link to NPTEL course contents: https://nptel.ac.in/courses/112101099/

   https://nptel.ac.in/downloads/112101098/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1.	T-1	15	1 Hour.	Syllabus covered up to T-1
2.	T-2	25	1.5 Hours	Syllabus covered up to T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Approved in Academic Council Meeting held on 28 July, 2021

Signal Processing for IOT

COURSE CODE: 21M1WEC135

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE L-

T-P: 3-0-0

Pre-requisite: Digital signal processing, MATLAB Programming,

Course Objectives:

1. To provide the knowledge of the role of signal processing techniques for IOT applications.
2. To provide the practical implementation of signal processing techniques for IOT applications

Course Outcomes:

Course Outcomes ()		**Level of Attainment**
CO-1	Able to understand the sparse signal processing and its application in IOT.	Familiarity
CO-2	Able to understand the wavelet transform and its applicability in IOT	Familiarity
CO-3	Able to understand how signal processing provides an important role in energy efficiency, security and reliability for IOT.	Familiarity
CO-4	Able to understand the applicability of deep learning and TFA tools in IOT.	Assessment

Course Contents:

S. No.	**Contents**	**Contact Hours**
1	**Compressive sensing and sparse signal processing for IOT** Compressed Acquisition and Denoising Recovery of EMGdi Signal in WSNs and IoT, Compressed Sensing Signal and Data Acquisition in Wireless Sensor Networks and Internet of Things, Study on Secrecy Capacity of Wireless Sensor Networks in Internet of Things Based on the Amplify-and-Forward Compressed Sensing, Communication-Efficient Federated Learning Based on Compressed Sensing, Learning-based Sparse Data Reconstruction for Compressed Data Aggregation in IoT Networks, Sparse Signal Processing for Grant-Free Massive Connectivity: A Future Paradigm for Random Access Protocols in the Internet of Things, Compressed Sensing via Dictionary Learning and Approximate Message	14

	Passing for Multimedia Internet of Things, ECG Signal Reconstruction on the IoT-Gateway and Efficacy of Compressive Sensing Under Real-Time Constraints,	
2	**Wavelet transform for IOT** Insights Into IoT Data and an Innovative DWT-Based Technique to Denoise Sensor Signals, Industrial Pollution Areas Detection and Location via Satellite-Based IIoT, , RF Fingerprinting of IoT Devices Based on Transient Energy Spectrum, Learning Time-Frequency Analysis in Wireless Sensor Networks. IoMT-Based Association Rule Mining for the Prediction of Human Protein Complexes, Neuro-Detect: A Machine Learning-Based Fast and Accurate Seizure Detection System in the IoMT, An Efficient IoT-Based Platform for Remote Real-Time Cardiac Activity Monitoring Filtering and applications, An Adaptive Outlier Detection and Processing Approach Towards Time Series Sensor Data,	14
3	**Role of signal processing security and reliability** Signal processing techniques for energy efficiency, security, and reliability in the IoT domain, An Effective Data Privacy Protection Algorithm Based on Differential Privacy in Edge Computing, A Novel Image Steganography Method for Industrial Internet of Things Security, Robust Watermarking Algorithm for Medical Volume Data in Internet of Medical Things	08
4	**Signal processing and deep learning for IOT** Signal processing techniques for IoT-based structural health monitoring, Deep Learning for Fault Diagnosis based on short-time Fourier transform for IOT application,	06
	Total	**42**

Suggested Text Book(s):

1. Fornasier, Massimo, and Holger Rauhut. "Compressive Sensing." Handbookof mathematical methods in imaging 1 (2015): 187-229.
2. Baraniuk, R. G. (2007). Compressive sensing [lecture notes]. IEEE signal processing magazine, 24(4), 118-121.
3. J. G. Proakis and D. G. Manolakis, “Digital Signal Processing”, 4th Edition, Prentice Hall, 2007.
4. Mallat S. A wavelet tour of signal processing. Elsevier; 1999 Sep 14.

Suggested Reference Book(s):

1. Zaknich, Anthony. Neural networks for intelligent signal processing. Vol. 4. World Scientific, 2003.
2. Swanson, David C. Signal processing for intelligent sensor systems with MATLAB. CRC Press, 2011.
3. Victor C. Chen, and Hao Ling, Time-frequency Transforms for Radar Imaging and Signal Analysis, Artech House Publishers, 2002

4. Karlheinz Gröchenig, Foundations of Time-Frequency Analysis, Birkhäuser publishers(Springer), 2001.
5. J. G. Proakis and D. G. Manolakis, “Digital Signal Processing”, 4th Edition, Prentice Hall, 2007.

Other useful resource(s):

Research papers:

1. F. Wu, K. Yang and Z. Yang, "Compressed Acquisition and Denoising Recovery of EMGdi Signal in WSNs and IoT," in IEEE Transactions on Industrial Informatics, vol. 14, no. 5, pp. 2210-2219, May 2018, doi: 10.1109/TII.2017.2759185.
2. S. Li, L. D. Xu and X. Wang, "Compressed Sensing Signal and Data Acquisition in Wireless Sensor Networks and Internet of Things," in IEEE Transactions on Industrial Informatics, vol. 9, no. 4, pp. 2177-2186, Nov. 2013, doi: 10.1109/TII.2012.2189222.
3. J. Guo et al., "Study on Secrecy Capacity of Wireless Sensor Networks in Internet of Things Based on the Amplify-and-Forward Compressed Sensing Scheme," in IEEE Access, vol. 7, pp. 185580-185589, 2019, doi: 10.1109/ACCESS.2019.2960603.
4. Vanus, J.; Fiedorova, K.; Kubicek, J.; Gorjani, O.M.; Augustynek, M. Wavelet-Based Filtration Procedure for Denoising the Predicted CO2 Waveforms in Smart Home within the Internet of Things. Sensors 2020, 20, 620. https://doi.org/10.3390/s20030620
5. Zhang, Chengwen, Jun Shi, Zheming Zhang, Yutao Liu, and Xudong Hu. "FRFT-based interference suppression for OFDM systems in IoT environment." IEEE Communications Letters 23, no. 11 (2019): 2068-2072.
6. Al-Shayea, Tamara K., et al. "A Novel Gaussian in Denoising Medical Images with Different Wavelets for Internet of Things Devices." GLOBECOM 2020-2020 IEEE Global Communications Conference. IEEE, 2020.
7. Tian, Qiao, Yun Lin, Xinghao Guo, Jinming Wen, Yi Fang, Jonathan Rodriguez, and Shahid Mumtaz. "New security mechanisms of high-reliability IoT communication based on radio frequency fingerprint." IEEE Internet of Things Journal 6, no. 5 (2019): 7980-7987.
8. M. Zhang, H. Zhang, D. Yuan and M. Zhang, "Learning-based Sparse Data Reconstruction for Compressed Data Aggregation in IoT Networks," in *IEEE Internet of Things Journal*, doi: 10.1109/JIOT.2021.3059735.
9. Djelouat, H.; Amira, A.; Bensaali, F. Compressive Sensing-Based IoT Applications: A Review. *J. Sens. Actuator Netw.* 2018, *7*, 45. https://doi.org/10.3390/jsan7040045
10. L. Liu, E. G. Larsson, W. Yu, P. Popovski, C. Stefanovic and E. de Carvalho, "Sparse Signal Processing for Grant-Free Massive Connectivity: A Future Paradigm for Random Access Protocols in the Internet of Things," in IEEE Signal Processing Magazine, vol. 35, no. 5, pp. 88-99, Sept. 2018, doi: 10.1109/MSP.2018.2844952.
11. Z. Li, H. Huang and S. Misra, "Compressed Sensing via Dictionary Learning and Approximate Message Passing for Multimedia Internet of Things," in IEEE Internet of

Things Journal, vol. 4, no. 2, pp. 505-512, April 2017, doi: 10.1109/JIOT.2016.2583465.
12. M. L. Lopes De Faria, C. E. Cugnasca and J. R. A. Amazonas, "Insights Into IoT Data and an Innovative DWT-Based Technique to Denoise Sensor Signals," in *IEEE Sensors Journal*, vol. 18, no. 1, pp. 237-247, 1 Jan.1, 2018, doi: 10.1109/JSEN.2017.2767383.
13. J. Liu, J. Ma, J. Li, M. Huang, N. Sadiq and Y. Ai, "Robust Watermarking Algorithm for Medical Volume Data in Internet of Medical Things," in IEEE Access, vol. 8, pp. 93939-93961, 2020, doi: 10.1109/ACCESS.2020.2995015.
14. Y. Qiao et al., "An Effective Data Privacy Protection Algorithm Based on Differential Privacy in Edge Computing," in IEEE Access, vol. 7, pp. 136203-136213, 2019, doi: 10.1109/ACCESS.2019.2939015.
15. M. Hassaballah, M. A. Hameed, A. I. Awad and K. Muhammad, "A Novel Image Steganography Method for Industrial Internet of Things Security," in *IEEE Transactions on Industrial Informatics*, doi: 10.1109/TII.2021.3053595.
16. M. Zhang, X. Li and L. Wang, "An Adaptive Outlier Detection and Processing Approach Towards Time Series Sensor Data," in IEEE Access, vol. 7, pp. 175192-175212, 2019, doi: 10.1109/ACCESS.2019.2957602.
17. M. Zhang, X. Li and L. Wang, "An Adaptive Outlier Detection and Processing Approach Towards Time Series Sensor Data," in *IEEE Access*, vol. 7, pp. 175192-175212, 2019, doi: 10.1109/ACCESS.2019.2957602.
18. L. Wan, Y. Sun, I. Lee, W. Zhao and F. Xia, "Industrial Pollution Areas Detection and Location via Satellite-Based IIoT," in *IEEE Transactions on Industrial Informatics*, vol. 17, no. 3, pp. 1785-1794, March 2021, doi: 10.1109/TII.2020.2992658.
19. A. Ahmadi *et al*., "Toward Automatic Activity Classification and Movement Assessment During a Sports Training Session," in *IEEE Internet of Things Journal*, vol. 2, no. 1, pp. 23-32, Feb. 2015, doi: 10.1109/JIOT.2014.2377238.
20. S. Raj, "An Efficient IoT-Based Platform for Remote Real-Time Cardiac Activity Monitoring," in *IEEE Transactions on Consumer Electronics*, vol. 66, no. 2, pp. 106-114, May 2020, doi: 10.1109/TCE.2020.2981511.
21. M. Sikarndar, W. Anwar, A. Almogren, I. Ud Din and N. Guizani, "IoMT-Based Association Rule Mining for the Prediction of Human Protein Complexes," in *IEEE Access*, vol. 8, pp. 6226-6237, 2020, doi: 10.1109/ACCESS.2019.2963797.
22. H. Zou, Y. Zhou, R. Arghandeh and C. J. Spanos, "Multiple Kernel Semi-Representation Learning With Its Application to Device-Free Human Activity Recognition," in *IEEE Internet of Things Journal*, vol. 6, no. 5, pp. 7670-7680, Oct. 2019, doi: 10.1109/JIOT.2019.2901927.
23. M. Köse, S. Taşcioğlu and Z. Telatar, "RF Fingerprinting of IoT Devices Based on Transient Energy Spectrum," in *IEEE Access*, vol. 7, pp. 18715-18726, 2019, doi: 10.1109/ACCESS.2019.2896696.
24. Z. Sun, L. Zhou and W. Wang, "Learning Time-Frequency Analysis in Wireless Sensor Networks," in *IEEE Internet of Things Journal*, vol. 5, no. 5, pp. 3388-3396, Oct. 2018, doi: 10.1109/JIOT.2017.2771514.

25. M. A. Sayeed, S. P. Mohanty, E. Kougianos and H. P. Zaveri, "Neuro-Detect: A Machine Learning-Based Fast and Accurate Seizure Detection System in the IoMT," in *IEEE Transactions on Consumer Electronics*, vol. 65, no. 3, pp. 359-368, Aug. 2019, doi: 10.1109/TCE.2019.2917895.
26. T. BENKEDJOUH, N. ZERHOUNI and S. RECHAK, "Deep Learning for Fault Diagnosis based on short-time Fourier transform," *2018 International Conference on Smart Communications in Network Technologies (SaCoNeT)*, El Oued, Algeria, 2018, pp. 288-293, doi: 10.1109/SaCoNeT.2018.8585444.
27. M. Al Disi *et al*., "ECG Signal Reconstruction on the IoT-Gateway and Efficacy of Compressive Sensing Under Real-Time Constraints," in *IEEE Access*, vol. 6, pp. 69130-69140, 2018, doi: 10.1109/ACCESS.2018.2877679.
28. M. A. Mahmud, A. Abdelgawad, K. Yelamarthi and Y. A. Ismail, "Signal processing techniques for IoT-based structural health monitoring," *2017 29th International Conference on Microelectronics (ICM)*, Beirut, Lebanon, 2017, pp. 1-5, doi: 10.1109/ICM.2017.8268825.
29. Nawaz, Menaa, Jameel Ahmed, Ghulam Abbas, and Mujeeb Ur Rehman. "Signal Analysis and Anomaly Detection of IoT-Based Healthcare Framework." In 2020 Global Conference on Wireless and Optical Technologies (GCWOT), pp. 1-6. IEEE, 2020.
30. Fragkiadakis, Alexandros, Elias Tragos, Antonis Makrogiannakis, Stefanos Papadakis, Pavlos Charalampidis, and Manolis Surligas. "Signal processing techniques for energy efficiency, security, and reliability in the IoT domain." In Internet of Things (IoT) in 5G Mobile Technologies, pp. 419-447. Springer, Cham, 2016.

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1.	T-1	15	1 Hour.	Syllabus covered up to T-1
2.	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

COs/POs													Average
CO-1	3	3	2	2	2	3	3	2	3	3	3	3	2.666667
CO-2	3	3	3	3	3	3	3	3	3	3	3	3	3
CO-3	3	3	3	3	3	2	3	3	2	3	3	3	2.833333
CO-4	3	3	3	3	3	3	2	3	3	3	3	3	2.916667
Average	3	3	2.75	2.75	2.75	2.75	2.75	2.75	2.75	3	3	3	

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Intelligent Signal Processing

COURSE CODE: 21M1WEC136

COURSE CREDITS: 3

CORE/ELECTIVE: Elective core

L-T-P: 3-0-0

Pre-requisite: Signals and Systems, MATLAB Programming,

Course Objectives:

To provide the knowledge of the concept of signal processing and neural networks.

To provide the basic knowledge of intelligent signal processing along with its practical implementation.

Course Outcomes:

Course Outcomes ()		**Level of Attainment**
CO-1	Able to understand the basic concept of spectral analysis	Familiarity
CO-2	Able to understand the concept of time-frequency analysis	Familiarity & Usage
CO-3	Able to understand the concept of wiener filtering and steepest descent algorithm	Familiarity & Usage
CO-4	Able to understand the role of neural network and deep neural network for signal processing applications	Familiarity & Usage
CO-5	Able to understand the overall concept of intelligent signal processing	Assessment

Course Contents:

S. No.	**Contents**	**Contact Hours**
1	Spectral Estimation, Parametric spectral methods, Non-Parametric Methods, Minimum Variance Spectrum Estimation, Maximum Entropy Method, Frequency Estimation Method, Parametric Methods, Principal Component Spectrum Estimation Method	10
2	Introduction of the Time-Frequency analysis methods, Non-stationary signals, Short time Fourier transform, spectrogram, continuous wavelet transform, scalogram, and DWT	10
3.	Wiener Filter Theory and its Application, Steepest Descent Algorithm, LMS Algorithm.	08
4	Basic neural network, deep neural network and their use in signal processing applications.	04
5	Applications of digital signal processing and neural networks in genomics data analysis, ECG analysis, EMG analysis, EEG analysis, respiratory sound analysis, lung sound analysis, vibration signal analysis, spectrum	10

	sensing, modulation analysis, and micro-Doppler signature analysis, Intelligent Radio Signal Processing: A Survey	
	Total	**42**

Suggested Text Book(s):

1. M. H. Hayes, Statistical Digital Signal Processing and Modelling, John Wiley & Sons, Student Edition, 2013.
2. Boualem Boashash, Time-frequency signal analysis and processing: A comprehensive reference, 2nd Edition, Academic Publishers (Elsevier), 2016.
3. Recently published research papers based on time-frequency analysis with machine learning or deep learning.

Suggested Reference Book(s):

1. Zaknich, Anthony. *Neural networks for intelligent signal processing*. Vol. 4. World Scientific, 2003.
2. Swanson, David C. *Signal processing for intelligent sensor systems with MATLAB*. CRC Press, 2011.
3. I. Goodfellow, Y, Bengio, A. Courville, Deep Learning", MIT Press, 2016.
4. Ruano, Antonio, and Annamária R. Várkonyi-Kóczy, eds. *New Advances in Intelligent Signal Processing*. Vol. 372. Springer Science & Business Media, 2011.
5. Simon Haykin, Bart Kosko, "Intelligent Signal Processing" IEEE xplore, 2001
6. Victor C. Chen, and Hao Ling, Time-frequency Transforms for Radar Imaging and Signal Analysis, Artech House Publishers, 2002
7. Karlheinz Gröchenig, Foundations of Time-Frequency Analysis, Birkhäuser publishers(Springer), 2001.
8. J. G. Proakis and D. G. Manolakis, "Digital Signal Processing", 4th Edition, Prentice Hall, 2007.

Other useful resource(s):

1. http://dsp.rice.edu/cs/
2. https://www.signalprocessingsociety.org/uploads/history/history.pdf
3. http://pfister.ee.duke.edu/courses/ece485/
4. https://www.wiley.com/en-in/Intelligent+Signal+Processing-p-9780780360105
5. https://ieeexplore.ieee.org/book/5265588
6. https://www.sciencedirect.com/science/article/abs/pii/S0266353802000088
7. https://www.ncl.ac.uk/engineering/research/electrical-electronic-engineering/intelligent-sensing-communication/signal-processing-ai/
8. https://www.ncl.ac.uk/postgraduate/modules/EEE8129/
9. https://www.youtube.com/watch?v=EErkgr1MWw0
10. https://www.youtube.com/watch?v=GZ3KUPqA1J M
11. https://www.coursera.org/learn/advanced-machine-learning-signal-processing

12. https://aims.asu.edu/signal-processing-for-st ructural-health-monitoring/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered up to T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

COs/POs													Average
CO-1	3	3	2	2	2	3	3	2	3	3	3	3	2.666667
CO-2	3	3	3	3	3	3	3	3	3	3	3	3	3
CO-3	3	3	3	3	3	2	3	3	2	3	3	3	2.833333
CO-4	3	3	3	3	3	3	2	3	3	3	3	3	2.916667
CO-5	3	3	3	3	3	3	3	3	3	3	3	3	3
Average	3	3	2.8	2.8	2.8	2.8	2.8	2.8	2.8	3	3	3	

Advanced IoT Lab – I

COURSE CODE: 21M11EC271

COURSE CREDITS: 6

CORE/ELECTIVE:

: 0-0-6

Pre-requisite:

Course Objectives:

This lab will include experiments on embedded systems and its interfacing with sensors.

- Experiments will be performed using ARM processor, PIC microcontroller, and 8051 microcontroller.
- Experiments based on Firebird-V Robotics Research Platform will be performed
- Experiments with virtual instrumentation with LabView will be performed in this Lab.
- Project work/Implementation of the research papers is also included in this lab.

Digital System Design Using Verilog HDL

COURSE CODE: 21M11EC211

COURSE CREDITS: 3

CORE/ELECTIVE: CORE

L-T-P: 3-0-0

Pre-requisite: Basic course in Digital Electronics & Logic Design

Course Objectives:

1. Designing digital circuits, behaviour and RTL modeling of digital circuits using verilog HDL, verifying these Models and synthesizing RTLmodels to standard cell libraries and FPGAs.

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2. Students gain practical experience by designing, modeling, implementing and verifying several digital circuits.

Course Outcomes:

Sl. No.	Course Outcomes	Level of Attainment
1	To understand the constructs and conventions of the Verilog HDLprogramming.	Familiarity
2	To understand the structural, register-transfer level (RTL), and algorithmic levels of abstraction for modelling digital hardware systems.	Usage
3	To design and modelling of combinational and sequential digital systems (FiniteState Machines).	Usage, Assessment
4	To understand and apply the concept of test-benches to create testing behavioural environments for simulation based verification	Usage, Assessment

Course Contents:

Unit	Contents	Lectures required
1	Introduction to Logic circuits and implementation technology: Logic gates, Boolean algebra, design examples, CAD tools, introduction to verilog, Programmable Logic devices and types, Optimized implementation of Logic Functions	3
2	Verilog as HDL, Levels of design Description, Concurrency, Simulation and Synthesis, Functional verification, System Tasks, Programming Language Interface (PLI), Module, Simulation and Synthesis Tools, Test Benches	4
3	Introduction, Keywords, Identifiers, White Space Characters, Comments, Numbers, Strings, Logic Values,Strengths, Data Types, Scalars and Vectors, Parameters, Operators, AND Gate Primitive,Module Structure, Other Gate Primitives, Illustrative Examples, Tri-State gates, Array of Instances of Primitives, Design of Flip –Flops with gate primitives, Delays, Strengths and contention Resolution, Net Types, Design of BasicCircuits.MODELING AT DATA FLOW LEVEL: Introduction, Continuous Assignment Structures, Delays and Continuous Assignments, Assignment to vectors, Operators	7
4	BEHAVIORAL MODELING: Introduction, Operations and Assignments, Functional Bifurcation, Initial Construct, Always Construct, assignments with Delays, Wait Construct, Multiple Always Blocks, Designs at Behavioural Level, Blocking and Non-Blocking Assignments, The case statement, Simulation Flow if and if-else constructs, assign–design construct, repeat construct, for loop, the disable construct, while loop, forever loop, parallel	4

	blocks, force-release construct, Event.	
5	Arithmetic circuits: number representation review, arithmetic circuits (adders and multipliers using CAD, Combinational circuit building blocks: Multiplexers, decoders, encoders, using verilog HDL.	4
6	Flip-Flops, Registers, Counters and Simple Processor: Latches, Flip-flops. Registers, counters and types, Reset Synchronization, Using Storage Elements in verilog HDL, Design Examples and timing concepts	6
7	Synchronous Sequential Circuits with verilog: BasicDesign Steps, One hot encoding, Mealy State Model, Moore tupe FSM Design of FSM using verilog, Design Examples, FSM as arbitrator circuit, ASM	6
8	Asynchronous sequential circuits: Behaviour, Analysis and synthesis, State Reduction, State assignment, Hazards, a complete design example	4
9	Digital System Design: Building Block circuits, clock synchronization concepts, various design examples, Testing of Logic Circuits: Fault models, path sensitizing, testing of sequential circuits, Built in self test: boundary scan	4
Total lectures		**42**

Suggested Text Book(s):

1. Fundamentals of Digital Logic design with Verilog Design –Stephen Brown and Zvonko Vranesic, TMH, 2ndEdition,2010.

2. Advanced Digital Design with Verilog HDL –Michael D. Ciletti, PHI, 2005.

Suggested Reference Book(s):

Other useful resource(s):

1. T. R. Padmanabhan and B. Bala Tripura Sundari, Design through Verilog HDL – Wiley,2009.(T1) .Zainalabdien Navabi, Verilog Digital System Design, TMH, 2ndEdition

2. Verilog HDL –Samir Palnitkar, 2ndEdition, Pearson Education, 2009.

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered up to T-1
2	T-2	25	1.5 Hours	Syllabus covered up to T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course outcomes (Digital System Design Using Verilog HDL)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	3	3	2	2	3	3	2	3	3	3	2.75
CO-2	3	3	2	2	2	1	2	2	2	3	3	3	2.4
CO-3	3	3	3	2	2	1	2	3	2	3	3	3	2.5
CO-4	3	3	3	3	2	3	2	3	2	2	3	3	2.6
Average	3	3	2.75	2.5	2	1.75	2.25	2.75	2	2.75	3	3	

Artificial Intelligence and Expert Systems

COURSE CODE: 21M11EC212

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Prerequisites are good programming skills, basic data structures and algorithms, and some university level mathematics.

Course Objectives:

1. To understand the concept of designing expert systems which exhibit intell gent behavior.
2. To study and create expert systems which exhibit the capability to learn, demonstrate, explain and advise its users.
3. To learn artificial intelligent systems finding solutions to complex problems.
4. To design human-like machines in a computer friendly manner.
5. To study State of the Art algorithms with engineering applications.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	To analyze the need and foundation of Artificial Intelligence and expert systems	Familiarity
CO-2	Study the various types of expert systems that receive precepts from the environment and perform actions	Assessment
CO-3	Analysis of problem solving, knowledge and reasoning	Assessment
CO-4	Study of application domains of Artificial Intelligence	Usage

Course Contents:

Unit	Contents	Lectures required
1	**Introduction to Artificial Intelligence:** What is Artificial Intelligence (AI), The foundations of AI, The birth of AI, Knowledge based Systems, The State of the Art techniques.	7
2	**Intelligent Agents:** Agents and Environments, The concept of Rationality, Performance Measures, The structure of Agents, Agent Programs, Simple reflex Agents, Model based reflex Agents, Goal based Agents, Utility based Agents, Learning Agents.	7
3	**Problem Solving:** Problem solving Agents, Formulating Problems, Searching for Solutions, Uninformed Search Strategies, Breadth first search, Depth first search, Depth limited Search, Bidirectional search, Informed Search Exploration, Constraint Satisfaction Problems	7

4	**Knowledge and Reasoning:** Knowledge based agents, Reasoning Patterns in Propositional Logic, Forward and Backward Chaining, Backtracking Algorithm, First Order Logic, Knowledge Representation, Uncertain Knowledge and Reasoning	**7**
5	**Learning:** Laning from Observations, Forms of Learning, Inductive Learning, Learning Decision Trees, Ensemble Learning, Knowledge in Learning, Statistical Learning, Reinforcement Learning	**7**
6	**Perception and Action:** Communication as Action, Fundamental of Language, Syntactic Analysis, Semantic Interpretation, Probabilistic Language Processing, Perceptual analysis, Robotic Hardware and software Architectures.	**7**
Total lectures		**42**

Suggested Text Book(s):

1. Stuart J. Russel and Peter Norvig, "Artificial Intelligence: A Modern Approach" Second Edition, Pearson Prentice Hall.
2. E. rich and K. Knight, "Artificial Intelligence and Applications" Third Edition, Tata Mcgraw Hill.

Suggested Reference Book(s):

1. P. Kulkarni and P. Joshi, "Artificial Intelligence", PHI Learning Private Limited, 2015.
2. P. H. Winston, Artificial Intelligence and Applications", PHI Learning Private Limited, 2017.

Other useful resource(s):

Link to topics related to course:

i. https://nptel.ac.in/courses/106105077/
ii. https://www.tutorialspoint.com/artificial_intelligence/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1.	T-1	15	1 Hour.	Syllabus covered upto T-1
2.	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10

				Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Artificial Intelligence and Expert Systems)													
CO-1	2	2	3	3	2	1	1	1	2	2	2	2	**2**
CO-2	2	3	3	3	2	1	1	1	2	2	1	2	**2**
CO-3	2	3	3	3	2	1	1	1	2	2	1	2	**2**
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	**2**
Average	**2**	**3**	**3**	**3**	**2**	**1**	**1**	**1**	**2**	**2**	**3**	**2**	

Network Security Protocols

COURSE CODE: 21M11EC213

COURSE CREDITS: 3

CORE/ELECTIVE: CORE

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

1. To understand the concept of network security.
2. Familiarization of various security protocols implemented at different layers.

Course Outcomes:

Sl. No.	Course Outcomes	Level of Attainment
CO-1	Understand the threats posed to network security and the more common attacks associated with those threats	Familiarity
CO-2	Understand the threats present in computer networks and counter measures for the same	Usage
CO-3	Analyzing the security protocols at different layers of the OSI model.	Usage
CO-4	Gain knowledge of authentication processes and security in the wireless networks.	Assessment

Course Contents:

Unit	Contents	Lectures required
1.	Introduction: Computer security concepts; OSI security architecture Security attacks, Security mechanisms, A model for network security, Standards	5
2.	Understanding network security: Network security: Physical security, Pseudo security, Hardware security, Software security; Security services: Access control, Authentication, Confidentiality, Integrity, Non-repudiation; Security standards, Elements of security. DoS Attacks, Firewall and Intrusion prevention systems	8
3.	Security threats to Computer Networks: Introduction; Sources of security threats; Security threat motives; Security threat management; Security threat correlation; Security threat awareness.	6
4.	Security protocols in network layer: Security at different layers: pros and cons; Internet protocol security (IPSec): IPSec security associations, IPSec protocols: AH and ESP, Tunnel versus transport mode, Incompatibility with	6

	NAT, Internet key exchange protocol.	
5.	Security protocols in transport layer: Secure socket layer (SSL) handshake protocol: Steps in handshake, Key design ideas; SSL record layer protocol, OpenSSL, Transport layer security (TLS).	6
6.	Security protocols in application layer: Pretty good privacy (PGP), Secure/multipurpose internet mail extension (S/MIME), Secure-HTTP (S-HTTP), Hypertext transfer protocol over secure socket layer (HTTPS), Secure electronic transactions (SET), Kerberos.	6
7	Security in wireless networks and devices: GSM (2G) security, Security in UMTS (3G), Wireless LAN security: authentication, confidentiality and integrity.	5
Total lectures		42

Suggested Text Book(s):

1. Cryptography and Network Security: principle and practices Wiliam Stallings.
2. Computer Network Security, Joseph Migga Kizza.
3. Cryptography, Network Security, and Cyber Laws / Bernard L. Menezes.

Suggested Reference Book(s):

Other useful resource(s):

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1.	T-1	15	1 Hour.	Syllabus covered up to T-1
2.	T-2	25	1.5 Hours	Syllabus covered up to T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programmed Outcomes (POs)

Course outcomes (Network security protocols)													
CO-1	1	2	2	2	3	1	1	1	1	2	2	3	**1.75**
CO-2	3	3	2	2	2	2	2	1	2	2	1	2	**2**
CO-3	3	1	2	1	2	2	2	2	2	3	1	1	**1.83**
CO-4	3	3	2	2	2	2	1	2	1	2	2	1	**1.91**
Average	**2.5**	**2.25**	**2**	**1.75**	**2.25**	**1.75**	**1.5**	**1.5**	**1.5**	**2.25**	**1.5**	**1.75**	

Image Sensing and Real Time Processing

COURSE CODE: 21M1WEC231

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Prerequisites image processing concepts. are good programming skills, basic signals and systems and

Course Objectives:

1. To understand the concept of designing image processing algorithms.
2. Study on various types of image sensing elements.
3. To study the implementation of image processing algorithms for real world problems.
4. To understand the mathematical concepts and principles behind the real time image processing techniques.
5. Application studies on image processing used in research and industry.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	To analyze the basic concepts of accessing and storing the image data	Familiarity
CO-2	Study and implement real world image processing algorithms used in research and industry.	Assessment
CO-3	Analysis of real world problems and their implementation issues.	Assessment
CO-4	Study of state-of-the-art image processing techniques.	Usage

Course Contents:

Unit	Contents	Lectures require d
1	**Introduction to Image Sensing:** Human visual system, Light and Electromagnetic Spectrum, Image Sensing Elements, Camera and Lenses, Accessing Image Data, Image sampling and Quantization, Simplified image processing models	7
2	**Fundamental of Imaging:** Types of image and image formats, Gray Level Transformations, Geometric Transformation, Histogram Processing, Averaging and edge detection, Image Compression and Interpolation, Morphology.	7
3	**Spatial Doman Filtering:** 2D and 3D Convolution, Smoothing by convolution with a Gaussian, Computing first order and second order derivatives, Non-linear filters, Grayscale Morphological Operators	7

4	**Frequency domain Filtering:** 2D Fourier Transform and its properties, 2D Discrete Fourier Transform and its properties, Frequency domain low pass, high pass and bandpass filtering, Homomorphic Filtering, Discrete Wavelet Transform.	**7**
5	**Color Image Processing :** Physics and Psychology of color, Trichromacy, Grassmann's Law, Color image coding, Color Spaces and Liner color Transformation.	**7**
6	**Real Time Image Processing:** Study and implementation of real time image processing algorithm such as Medical Imaging, Remote Sensing, Underwater Images, RADAR Images, Microscopic Images and Industrial Images.	**7**
Total lectures		**42**

Suggested Text Book(s):

1. Rafael C. Gonzales, Richard E. Woods, "Digital Image Processing", fourth Edition, Pearson Education, 2018.

Suggested Reference Book(s):

1. Anil K. Jain, "Fundamentals of Digital Image Processing", First Edition, PHI Learning Pvt. Ltd, 2015
2. Willliam K Pratt, "Digital Image Processing", Fourth Edition, John Willey, 2007.
3. S.Sridhar, "Digital Image Processing", Second Edition, Oxford University Press, 2016
4. Rafael C. Gonzalez, Richard E. Woods, Steven L. Eddins, "Digital Image Processing Using MATLAB", Third Edition Tata Mc Graw Hill Pvt. Ltd., 2011.

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Artificial Image Sensing and Real Time Processing)													
CO-1	2	2	3	3	2	1	1	1	2	2	2	2	**2**
CO-2	2	3	3	3	2	1	1	1	2	2	1	2	**2**
CO-3	2	3	3	3	2	1	1	1	2	2	1	2	**2**
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	**2**
Average	**2**	**3**	**3**	**3**	**2**	**1**	**1**	**1**	**2**	**2**	**3**	**2**	

Medical Image Processing and Applications

COURSE CODE:21M1WEC232

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

1. To introduce various medical imaging modalities.
2. To teach the requirement and development of different blocks of computer aided diagnosis for medical images.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Able to understand different types of medical imaging modalities and would be able to differentiate them with respect to their advantages and limitations.	Familiarity
CO-2	Acquire an ability to analyze and process medical images.	Usage
CO-3	Understand different feature extraction techniques and classifiers used for image classification.	Usage
CO-4	Understand the role of computer aided diagnosis for medical images.	Assessment

Course Contents:

Unit	Contents	Lectures required
1	**Introduction to Image Processing:**- Acquisition of Images, Image Sampling and quantization; Spatial and histogram based enhancement; Noise modeling, Image restoration. Image transformation.	**8**
2	**Edge Detection and Image Segmentation:** Gradient based edge detectors. Intensity thresholding based image segmentation; Region growing and region splitting algorithm; watershed segmentation.	**8**
3	**Medical Imaging Modalities:** Working principle, applications and limitations of Computed tomography , X-ray, Magnetic resonance imaging, Ultrasound imaging, and Positron emission tomography; Various Artifacts.	**6**

Approved in Academic Council Meeting held on 28 July, 2021

4	**Image Texture:** Types of texture parameters: Statistical analysis of texture (First order statistics and Second order statistics), Grey level co-occurrence matrix, grey-level run length matrix.	**8**
5	**Pattern classification:** Supervised and Unsupervised pattern classification, Neural Network classifier, Support Vector Machines.	**6**
6	**Case Studies:** Pre-processing, Segmentation, Feature extraction, and Classification of medical images.	**6**
Total lectures		**42**

Suggested Text Book(s):

1. Chris Solomon, Toby Breckon: Fundamental of Digital Image Processing, 1st Ed.,John Wiley & Sons, 2011.
2. Rangaraj M. Rangayyan: Biomedical Image Analysis, 1st Ed., CRC Press, New York, 2004.

Suggested Reference Book(s):

1. RC Gonzalez, RE Woods, Digital Image Processing, 3rd Ed., Pearson Publisher, 2008.
2. Kayvan Najarian, Robert Splinter: Biomedical Signal and Image Processing, 2nd Ed., CRC Press, 2012
3. Tamal Bose: Digital Signal and Image Processing, 1st Ed., John Wiley & Sons, 2003.

Other useful resource(s):

1. http://www.nptelvideos.in/2012/12/digital-image-processing.html (Prof P.K. Biswas, IIT Kharagpur)

EvaluationScheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes(2) -10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Medical Image Processing)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	3	3	3	3	2	3	1	2	1	2	**2.42**
CO-2	3	3	3	3	2	0	0	1	2	3	1	1	**1.83**
CO-3	3	3	3	3	3	1	1	1	1	2	1	1	**1.92**
CO-4	3	3	3	3	3	3	2	3	2	2	3	3	**2.75**
Average	**3.00**	**3.00**	**3.00**	**3.00**	**2.75**	**1.75**	**1.25**	**2.00**	**1.50**	**2.25**	**1.50**	**1.75**	

Applied Machine Learning for IoT

COURSE CODE: 21M1WEC233

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Artificial Intelligence, C Language, Python Language

Course Objectives:

1. To provide a broad survey of approaches and techniques in machine learning and IoT.
2. To develop the design and programming skills that will help you to build intelligent, adaptive artifacts.
3. To develop the basic skills necessary to pursue research in machine learning and IoT.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Understand the basic theory underlying machine learning.	Familiarity
CO-2	Understand general concepts of Internet of Things and recognize various devices, sensors and applications	Familiarity
CO-3	Apply machine learning algorithms to solve problems of moderate complexity.	Assessment
CO-4	Design, build and integrate IoT platforms, incorporating different types of sensors, actuators and machine learning methods.	Assessment
CO-5	Read current research papers and understand the issues raised by current research.	Usage

Course Contents:

Unit	Contents	Lectures required
1	**Introduction to Machine Learning:** Definition of learning systems, Goals and applications of machine learning, Aspects of developing a learning system: training data, concept representation, Role of machine intelligence in IoT	5
2	**Machine Learning Models:** Bayesian classifiers, Nearest-neighbor classifiers, Linear and Polynomial classifiers, Random forests, Decision trees, Support vector machines, Dimensionality reduction methods, K-mean clustering, Artificial neural networks, Deep neural networks.	8
3	**Internet of Things:** Data Analytics, IoT analytics challenges, IoT data acquisition, Data Exploration and Pre-processing, IoT technologies, Architecture and Networking protocols, IoT Communication	8

	Technologies, Devices and Gateways,	
4	**Sensor & Actuators:** Overview of Sensors working, Analog and Digital Sensors, Interfacing of Temperature, Humidity, Motion, Light and Gas Sensor with Arduino, Interfacing of Actuators with Arduino, Interfacing of Relay Switch and Servo Motor with Arduino	**6**
5	**Computing framework:** Fog computing, Edge computing, Cloud computing, Characteristics of Cloud Computing, Driving factors towards cloud, Architecture, Role of Networks in Cloud computing, protocols used, Role of Web services, Service Models: IaaS, PaaS, SaaS, NaaS, Cloud Clients, Deployment Models: Public Clouds, Community Clouds, Hybrid Cloud, Private Cloud, Issues in Cloud Computing, Applications, Distributed computing.	**7**
6	**Applications of Machine learning in smart cities:** Use cases - Smart energy, Smart mobility, Smart citizens, Urban planning, Smart city data characteristics, Applied machine learning algorithms to Internet of Things use cases.	**8**
Total lectures		**42**

Suggested Text Book(s):

1. Vijay Madisetti, Arshdeep Bahga, "Internet of Things: A Hands-on Approach", University Press, 2014.
2. C.M. Bishop, Pattern Recognition and Machine Learning, Springer (2006)
3. J. Watt, R. Borhani and A. K. Katsaggelos: Machine Learning Refined: Foundations, Algorithms and Applications, Cambridge University Press, 1st ed., 2016.
4. Andrew Minteer: Analytics for the Internet of Things (IoT) Intelligent Analytics for Your Intelligent Devices, Packt Publishing, 2017

Suggested Reference Book(s):

1. D. Barber, Bayesian Reasoning and Machine Learning, Cambridge University Press (2012)
2. Michael Stanley and Jongmin Lee: Sensor Analysis for the Internet of Things, Morgan & Claypool Publishers, 2018.
3. Raj Kamal, "Internet of Things: Architecture and Design", McGraw Hill, 2017.
4. Cuno Pfister, "Getting Started with the Internet of Things", Oreilly Media, 2011.

Other useful resource(s):

1. H. Daume: A course in Machine Leaning, 2015. http://ciml.info/
2. Link to NPTEL course contents: Introduction to Machine Learning https://onlinecourses.nptel.ac.in/noc17_cs26/preview
3. Link to MITOPENCOURESEWARE: Machine Learning https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-867-machine-learning-

fall-2006/
4. Link to NPTEL course contents: Internet of Things https://nptel.ac.in/courses/106/105/106105166/
5. Link to NPTEL course contents: Internet of Things https://nptel.ac.in/courses/106105077
6. M. S. Mahdavinejad et al., "Machine learning for Internet of Things data analysis: A survey," Digit. Commun. Netw., vol. 4, no. 3, pp. 161–175, Aug. 2018. https://www.sciencedirect.com/science/article/pii/S235286481730247X
7. J. Jagannath, N. Polosky, A. Jagannath, F. Restuccia, and T. Melodia, "Machine learning for wireless communications in the Internet of Things: A comprehensive survey," Ad Hoc Netw., vol. 93, 2019. https://arxiv.org/abs/1901.07947

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (3) - 10 Quizzes (3) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Applied Machine Learning for IoT)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	2	2	2	2	2	1	1	2	3	3	**2.17**
CO-2	3	3	3	2	3	2	2	1	1	2	3	3	**2.33**
CO-3	3	3	3	3	3	3	3	1	3	3	3	3	**2.83**
CO-4	3	3	3	3	3	3	3	1	3	3	3	3	**2.83**
CO-5	3	3	3	3	3	3	3	1	3	3	3	3	**2.83**
Average	**3.00**	**3.00**	**2.80**	**2.60**	**2.80**	**2.60**	**2.60**	**1.00**	**2.20**	**2.60**	**3.00**	**3.00**	

Antennas for IoT

COURSE CODE: 21MIWEC234

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Transmission lines and E.M waves.

Course Objectives:

The main objective of the course is to

1. Learn the mechanism of antenna, antenna performance parameters.
2. Design and analysis of various antennas for different applications.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Understand key benefits of smart antenna technology, wide band smart antennas, Propagation Channels..	Familiarity
CO-2	To do analysis of Multiple Input - Multiple Output (MIMO) Communications Systems	Familiarity
CO-3	To analyze the channel models for antenna systems for IoT Applications.	Usage
CO-4	To study the environmental parameters for signal processing of smart antenna systems	Usage
CO-5	To evaluate the requirements for the design and implementation of smart antenna systems.	Assessment

Course Contents:

Unit	Contents	Lectures required
1.	**Introduction:** Antenna Basics, Phased array antenna, power pattern, beam steering, degree of freedom, adaptive antennas, smart antennas – key benefits of smart antenna technology, wide band smart antennas, Propagation Channels	6
2.	**Smart Antennas For Wireless Communications:** Spatial Processing for Wireless Systems, Key Benefits of Smart Antenna Technology, The Vector Channel Impulse Response and the Spatial Signature, Spatial Processing Receivers, Fixed Beam forming Networks, Switched Beam Systems, Adaptive Antenna Systems, Wideband Smart Antennas, Diversity Techniques, Multiple Input - Multiple Output (MIMO) Communications Systems, MIMO for frequency selective scenarios	6
	Adaptive Processing: Sample matrix inversion algorithm, unconstrained LMS algorithm, normalized LMS algorithm, Constrained LMS algorithm, Perturbation algorithms, neural network approach, Adaptive beam space processing, and Implementation issues.	

3.		6
4.	**Direction of Arrival Estimation (DOA) Methods:** Spectral estimation methods, linear prediction method, Maximum entropy method, Maximum likelihood method, Eigen structure methods, MUSIC algorithm – root music and cyclic music algorithm, the ESPRIT algorithm.	5
5.	**Implementation of Smart Antenna System:** DOA based beam former design using simulation and hardware. Adaptive beam forming implementation using Altera Stratix series FPGA, QRD RLS Algorithm. CORDIC algorithm.	7
6.	**Microstrip Antennas Rectangular patch antenna**: cavity and transmission line models, Circular patch antenna Coupling mechanisms, circular polarization, Microstrip arrays, Broadband and Multi band microstrip antennas, Compact Microstrip Antennas, Wearable microstrip antennas for 5G, medical, and IoT applications	7
7.	**Dielectric Resonator Antennas:** Introduction, radiation mechanism, advantages of DRA, types of DRA, feeding techniques, design method, modes, Wearable Metamaterial antennas for 5G, IoT, and medical applications	5
Total lectures		**42**

Suggested Text Book(s):

1. Constantine A. Balanis: Antenna Theory Analysis and Desin, John Wiley, 3rd Edition, 2009.
2. Antennas for All Applications, J. D. Kraus and R. J. Marhefka, McGraw-Hill, Inc, 3rd Ed.,2007.
3. T. S. Rappaport, Smart antennas: Adaptive arrays, algorithms and wireless position location, IEEE Press, 1998.
4. Frank Gross, Smart antennas for wireless communications, McGra-Hill, 2006.
5. S. Chandran, Adaptive antenna arrays, trends and applications, Springer, 2009.

Suggested Reference Book(s):

1. Antennas and Radio wave Propagation, R. E. Collin, McGraw-Hill, Inc, 3rd Ed, 2005.
2. Modern Antenna Design, T. A. Milligan, John Wiley & Sons, 2nd Ed., 2005.
3. Antenna Arrays, R. L. Haupt, John Wiley & Sons, Inc., 1st Ed., 2010.
4. Antenna Theory and Microstrip Antennas, D. G. Fang, CRC Press, 1st Ed., 2009.

Other useful resource(s):

Link to NPTEL course contents

1. https://nptel.ac.in/courses/108101092/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered up to T-1
2	T-2	25	1.5 Hours	Syllabus covered up to T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes(2) -10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Antennas for IoT)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	3	3	3	2	1	1	1	2	2	2	**2.2**
CO-2	2	3	3	3	2	2	1	1	2	1	1	2	**1.9**
CO-3	2	2	2	3	2	2	1	1	1	2	1	3	**1.8**
CO-4	2	2	3	3	2	1	1	2	2	2	2	2	**2**
CO-5	2	2	3	3	3	2	1	1	2	2	1	2	**2**
Average	**2.2**	**2.4**	**2.8**	**3**	**2.4**	**1.8**	**1**	**1.2**	**1.6**	**1.6**	**1.4**	**2.2**	

RF technology for 5G and IoT

COURSE CODE: 21M1WEC235

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Digital communications, Mobile Communications / Wireless Communications

Course Objectives:

The main objective of the course is to

1. To gather the latest developments in the domain of wireless communication technology leading to 5G air interface.

2. To learn about technology changes that are expected to be engines of 5G air interface/ radio access technology.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	To learn about new waveforms (termed as 5G NR, the new radio)	Familiarity
CO-2	To understand the millimeter wave technology.	Familiarity
CO-3	To analyze massive multiple antenna technologies.	Usage
CO-4	To understand non orthogonal multiple access and heterogeneous networks such as small cells and device to device communications	Usage
CO-5	To get acquitted with energy savings in radio access network and ubiquitous quality of service.	Assessment

Course Contents:

Unit	Contents	Lectures required
1.	Introduction to RF technology for 5G and IoT, Overview of 5G communication technology, (operating scenarios, mm wave technology, propagation models), ITU-R recommendations, GSM, IMT-2000, requirements of IMT Advanced, Evolution of wireless Communication, Evolution of wireless Communication Standards From 2G to 5G.	6
2.	Requirements and operating scenarios of 5G, 5G scenarios, Ultra reliable low latency communication, Minimum requirements towards IMT-2020,Designing 5G new radio	8
3.	Basic Signal Model, Fundamental Framework for waveform analysis, Waveform Design Aspects of 2G, Waveforms in 3G, Waveform in 4G and 5G (OFDM),	7

	Waveform in 4G and 5G (OFDMA, SCFDMA, SCFDE),	
4.	Waveform in 5G, Waveform in 5G Numerology, Frame Structure in 5G NR, Numerology in 5G and adaptive subcarrier bandwidth, Waveforms beyond 5G, Waveform beyond 5G (Precoded GFDM)	7
5.	Comparison of waveforms, Channel models for performance evaluation, MIMO Signal Processing (Receive Diversity), MIMO Signal Processing (Capacity), MIMO Signal Processing (Capacity & Massive MIMO)	7
6.	Introduction to 5G Sub-6 GHz Bands, Distribution of arrival time of clusters, power angular spectrum, K-factor, the rician k-factor expression for modified Saleh-Valenzuela channels, Spatial Co-relation in 3GPP MIMO Systems,3GPP Clustering Environment, Challenges with massive MIMO, Analog Beam forming, Digital Beam forming, Hybrid beamforming (mm Wave)	7
Total lectures		**42**

Suggested Text Book(s):

1. Wei Xiang, Kan Zheng, Xuemin (Sherman) Shen: 5G Mobile Communications, Springer,1st Edition, 2017.
2. Yang, Y., Xu, J., Shi, G., Wang, C.-X.: 5G Wireless Systems, Springer, 1st Edition, 2018.

Suggested Reference Book(s):

1. Howard Huang, Constantinos B. Papadias, Sivarama Venkatesan: MIMO Communication for Cellular Networks, Springer, 1st Edition, 2012.
2. Robert W. Heath Jr.: Foundations of MIMO Communication, Cambridge University Press, 1st Edition, 2018.

Other useful resource(s):

Link to NPTEL course contents

2. **https://nptel.ac.in/courses/108/105/108105134/**

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered up to T-1
2	T-2	25	1.5 Hours	Syllabus covered up to T-2
3.	T-3	35	2 Hours	Entire Syllabus

Approved in Academic Council Meeting held on 28 July, 2021

4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes(2) -10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (RF technology for 5G and IoT)	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**Average**
CO-1	3	3	3	3	3	2	1	1	1	2	2	2	**2.2**
CO-2	2	3	3	3	2	2	1	1	2	1	1	2	**1.9**
CO-3	2	2	2	3	2	2	1	1	1	2	1	3	**1.8**
CO-4	2	2	3	3	2	1	1	2	2	2	2	2	**2**
CO-5	2	2	3	3	3	2	1	1	2	2	1	2	**2**
Average	**2.2**	**2.4**	**2.8**	**3**	**2.4**	**1.8**	**1**	**1.2**	**1.6**	**1.6**	**1.4**	**2.2**	

Smart Internet of Things

COURSE CODE: 21M1WEC236

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: C programming, Python, Data Analytics, Cloud Computing

Course Objectives:

1. To understand the application areas of Internet of things.
2. To examine the potential business opportunities that IoT can uncover.
3. To develop the basic skills necessary to pursue research in the field of Internet ofthings.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Recognize various devices, sensors and applications of IoT	Familiarity
CO-2	Apply design concept to IoT solutions.	Usage
CO-3	Create IoT solutions using sensors, actuators and Devices	Assessment
CO-4	Read current research papers and understand the issues raised by current research.	Usage

Course Contents:

Unit	Contents	Lectures required
1	**Introduction:** Relevance of IOT for the future, IOT in everyday life, Internet of Everything, IOT and Individual Privacy, Challenges in IOT implementation, Big Data Management, Connectivity challenges, Mission critical applications.	4
2	**Sensors & Microcontrollers:** Types of sensors, 8051 Microcontroller, ARM processor, Implementation of IoT with Arduino and Raspberry Pi, Intel Galileo,	6
3	**IoT Real Time Operating Systems:** Introduction Real time Operating Systems, GPOS vs. RTOS, Characteristics of RTOS, Application of RTOS, Internet of Things Real time Operating Systems: Contiki/FreeRTOS/RIOT/TinyOS, Application development using IoT RTOS	7
4	**IoT for Smart Appliances:** Understanding smart appliances, Operation, Monitoring, Energy saving, Maintenance, Smart Appliances use-cases: Smart refrigerator, Smart Oven, Smart Washer and Dryer	6
5	**IoT for Smart Home:** Automating the home, Steps to a smart home,	6

	Components for smart home, Smart home use-cases: Smart Furniture, Smart Lighting, Smart Security Systems, Smart Monitors.	

6	**IoT for Transportation:** Transportation and transports, Challenges, IoT architecture for transportation, IoT use-case for transportation: Connected cars, Connected fleet, Infrastructure and mass transit,	**6**
7	**IOT for smart cities:** IoT strategy for smart cities, Smart city IoT architecture, Smart city Security architecture, Smart city use-case examples: Connected street lighting, Smart Parking, Smart traffic control, Smart water management, Connected environment.	**7**
Total lectures		**42**

Suggested Text Book(s):

1. Michael Miller, "The Internet of Things: How Smart TVs, Smart Cars, Smart Homes, and Smart Cities Are Changing the World", QUE, 2015.
2. Shriram K Vasudevan, Abhishek S Nagarajan and RMD Sundaram, "Internet of Things", Wiley, Ist Edition, 2019.
3. David Hanes, Gonzalo Salgueiro, "IoT fundamentals: Networking technologies, Protocols, and use cases for the Internet of Things", Pearson, 2018

Suggested Reference Book(s):

1. Andrew Minteer: Analytics for the Internet of Things (IoT) Intelligent Analytics for Your Intelligent Devices, Packt Publishing, 2017
2. Michael Stanley and Jongmin Lee: Sensor Analysis for the Internet of Things, Morgan & Claypool Publishers, 2018.
3. Vijay Madisetti, Arshdeep Bahga, "Internet of Things: A Hands-on Approach", University Press, 2014.

Other useful resource(s):

1. Link to NPTEL course contents: Internet of Things https://nptel.ac.in/courses/106/105/106105166/
2. Link to NPTEL course contents: Internet of Things https://nptel.ac.in/courses/106105077

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (3) - 10 Quizzes (3) - 10

				Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Smart Internet of Things)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	2	2	2	2	2	1	1	2	3	3	**2.17**
CO-2	3	3	3	2	3	2	2	1	1	2	3	3	**2.33**
CO-3	3	3	3	3	3	3	3	1	3	3	3	3	**2.83**
CO-4	3	3	3	3	3	3	3	1	3	3	3	3	**2.83**
Average	**3.00**	**3.00**	**2.75**	**2.50**	**2.75**	**2.50**	**2.50**	**1.00**	**2.00**	**2.50**	**3.00**	**3.00**	

Advanced IoT Lab – II

COURSE CODE: 21M11EC271

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

This lab will include experiments based on the following topics:

- Communication networking systems for IoT.
- Development of complete IoT system for different applications
- Project work/Implementation of the research papers is also included in this lab.

Approved in Academic Council Meeting held on 28 July, 2021

Introduction to Sustainable Engineering and Energy Efficient Buildings

COURSE CODE:

CREDITS: 3

CORE/ELECTIVE: OPEN

ELECTIVEL-T-P: 3-0-0

Pre-requisites: Basic Physics & Mathematics

Course Objectives:

1. Understanding the concept of Sustainability
2. Introduction to various kinds of Pollutions and Global Environmental issues.
3. Understanding fundamentals Life Cycle Analysis.
4. Understanding the concept of EIA in India EMS and ISO 14001.
5. Introducing green Rating Systems and Energy Efficient Buildings.

Course Outcome

S. No.	Course Outcomes	Level of Attainment
CO-1	Introduction to the concept of Sustainability	Familiarity
CO-2	Introduction to various kinds of Pollutions and Global Environmental issues.	Familiarity
CO-3	Understanding fundamentals Life Cycle Analysis	Usage and Assessment
CO-4	Understanding the concept of EIA in India EMS and ISO 14001.	Familiarity
CO-5	Introducing green Rating Systems and Energy Efficient Buildings.	Usage and Assessment

Course Content

Unit	Concept	Lectures
1	**Understanding the concept of Sustainability** Introduction of the concept of Sustainability; Sustainable Development; Nexus between Technology and sustainable development; challenges to sustainable development; multilateral environmental agreements and protocols; clean development mechanism; Environmental legislations in India;	6

	Various measures adopted to promote sustainability; Carbon Credits and Carbon trading footprints.	
2	**Understanding about Pollution and Various Environmental Issues** Air Pollution; Effects of Air pollution; Water Pollution; Solid waste Management; Concept of Zero Waste; 3R concept; Global Environmental Issues; Global Warming; Ozone Depletion; Regional and Local Environmental Issues.	**7**
3	**Overview of LCA; EIA and EMS.** Environmental Management Standards; ISO 14000 series; Life Cycle Analysis; Environmental Impact Assessment; Procedures for EIA in India	**7**
4	**Understanding of Sustainable Materials** Concept of Sustainable Materials; Material Selection for sustainable design; Components of embodied energy, calculation of embodied energy for materials.	**5**
5	**Energy Efficient Systems and green building systems** Green buildings rating Systems Heating and ventilation design-Human thermal comfort, climatological factors, material specifications and heat transfer principles, Thermal performance evaluation, Heat loss from buildings, design of artificial ventilation system, design of insulators. Design audits & economic optimization-Concept of cost/benefit of energy conservation & carbon footprint estimation. Energy efficient lighting system design: Basic terminologies and standards, day lighting and artificial lighting design. Life Cycle energy use. Control of energy use in building, of LEED and TERI GRIHA ratings. Role of insulation and thermal properties of construction materials, influence of moisture content and modeling. Performance ratings of green buildings. Zero energy building.	**17**
Total lectures		**42**

NPTEL

https://nptel.ac.in/courses/105/102/105102175/
https://nptel.ac.in/courses/105/102/105102175/
https://nptel.ac.in/courses/105/105/105105157/
https://nptel.ac.in/courses/127/105/127105018/

Textbooks

1. National Building code
2. Energy Efficiency and Management Mehmet Kanoglu; Yunus A Cengel
3. Larry W Canter: Environmental Impact Assessment, Mc Graw Hill Publishers.
4. Introduction To Sustainability Environmental Social And Personal Perspectives 2Nd Edition by Martin Mulligan, Taylor & Francis

Evaluation Scheme

S. No.	Exam	Marks	Duration	Coverage/Scope of Examination
1.	T-1	15	1 Hour.	Syllabus covered upto T-1
2.	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Quiz (Best of 3) – 15 Marks Quiz (1) 5 Attendance - 5

Course Outcomes (COs) contribution to the Program Outcomes (POs)

Course Outcomes	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	1	2	2	2	3	3	3	1	2	3	3	**2**
CO-2	2	2	2	2	2	3	3	2	2	2	3	3	**2**
CO-3	3	2	2	2	2	3	3	3	2	1	2	3	**2**
CO-4	2	2	2	2	2	2	3	3	2	2	3	3	**2**
CO-5	2	1	2	2	2	2	3	2	2	2	2	3	**2**
Average	**2**	**1**	**2**	**2**	**2**	**2**	**3**	**2**	**1**	**2**	**2**	**3**	

Course description of Open Electives

Introduction to C++ Programming

COURSE CODE: XXX

COURSE CREDITS: 2

ELECTIVE: OPEN ELECTIVE

L-T-P: 2-0-0

Pre-requisite: C Programming

Course Objectives:

The object oriented programming paradigm is one of the popular programming paradigms of today. Due to its characteristics object orientation has added new dimensions in the software development process. In this course concept of Object Oriented Programming (OOP) is introduced and for this purpose C++ programming language is being used. C++ a very powerful general purpose programming language, which supports object oriented programming paradigm. This course covers basics of C++ programming language which includes data types, variables, operators, and array and pointers. Also, object oriented features such as class and objects, inheritance, polymorphism are covered in this course. Finally exceptions handling, I/O operations and STL are explained.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Learn the concepts of an Object-Oriented Programming	Familiarity
CO-2	Learn to define class, objects, object members, class members, data members, constructors and destructors	Usage
CO-3	Learn the concepts of Inheritance and Polymorphism in C++	Usage
CO-4	Learn the advanced features of C++, such as file handling, templates, and exception handling	Usage

Course Contents:

S No.	Contents	Lectures required
1	Object Oriented Programming Structured vs. Object Oriented Programming, Object Oriented Programming Concepts, Benefits of Object oriented programming, Object Oriented Languages.	2

2	Objects and Classes classification, Defining Classes, Encapsulation, Instantiating Objects, Member Functions, Accessibility labels, Static Members.	5
3	Constructors and Destructors Purpose of Constructors, Default Constructor, Parameterized Constructors, Copy Constructor, Destructor, Memory Management	3
4	Inheritance Concept of Reusability, Types of Inheritance, Single and Multiple Inheritance, Multilevel Inheritance.	3
5	Operator Overloading Function and Operator Overloading, Overloading Unary and Binary Operators.	3
6	Polymorphism and Virtual Function Abstract Class, Function Overriding, Dynamic Binding, Pure Virtual Functions.	3
7	Streams and Files Stream Classes, Types of I/O, Formatting Outputs, File Pointers, Buffer.	3
8	Templates and STL Function and Class Templates, Use of Templates, Standard Template Library.	3
9	Exception Handling Exceptions in C++ Programs, Try and Catch Expressions, Exceptions with arguments.	3
	Total Lectures	**28**

Suggested Text Book(s):

1. Lafore R., Object oriented programming in C++, Waite Group
2. Stroustrap B., The C++ Programming Language, Addison Wesley
3. Bruce Eckel, Thinking in C++

Evaluation Scheme:

S No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 hour.	Syllabus covered upto Test-1
2	T-2	25	1.5 hours	Syllabus covered upto Test-2
3	T-3	35	2 hours	Syllabus covered upto Test-3
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) -10 Attendance - 5

Course Outcomes (COs) contribution to the Programmed Outcomes (POs)

Course outcomes	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	1	2	2	1	2	2	1	1	1	3	3	**1.75**
CO-2	1	1	3	1	3	3	3	1	2	1	1	3	**1.92**
CO-3	2	2	1	2	1	1	2	3	1	3	2	1	**1.75**
CO-4	1	3	3	3	3	3	1	1	2	1	2	1	**2**
Average	**1.5**	**1.75**	**2.25**	**2**	**2**	**2.25**	**2**	**1.5**	**1.5**	**1.5**	**2**	**2**	

Introduction to C++ Programming Lab

COURSE CODE: XXX
COURSE CREDITS: 1
CORE/ELECTIVE: OPEN ELECTIVE
L-T-P: 0-0-2

Pre-requisite: Introduction to C programming

Course Objectives:

The object oriented programming paradigm is one of the popular programming paradigms of today. Due to its characteristics object orientation has added new dimensions in the software development process. In this course concept of Object Oriented Programming (OOP) is introduced and for this purpose C++ programming language is being used. C++ a very powerful general purpose programming language, which supports object oriented programming paradigm. This course covers basics of C++ programming language which includes data types, variables, operators, and array and pointers. Also, object oriented features such as class and objects, inheritance, polymorphism are covered in this course. Finally exceptions handling, I/O operations and STL are explained.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	Learn the concepts of an Object-Oriented Programming	Familiarity
CO-2	Learn to define class, objects, object members, class members, data members, constructors and destructors	Usage
CO-3	Learn the concepts of Inheritance and Polymorphism in C++	Usage
CO-4	Learn the advanced features of C++, such as file handling, templates, and exception handling	Usage

List of Experiments

S No	Description	Hours
1	Design and implement a class using C++ that keeps the basic information about an account in a bank (the basic information must include account number and balance). The class should have a constructor that is used to create a new account object. The class should also have a function that transfers a requested amount from an account (identified by an account number) to another account.	**2**

2	Design and implement a class BCD using C++. The BCD class accepts an integer value (maximum five decimal digit input) using an input function of the class and which separates the digits and then stores them in a data member array of the class. For example, if input was 123 then it will be stored in data member array as num (0) = 3, num (1) = 2; and num (2) =1; similarly if input number was 2345 then it will be stored as num (0) = 5, num (1) = 4, num (2) = 3 and num (3) = 2. The class has another member function that calculates the reverse of integer value and prints it. For example, the input value 2345 will be reversed and printed as 5432.	**2**
3	Design and implement a class "circle". You may assume that the circle may be represented by the centre and the radius. The class should have functions to calculate the area of the circle and at least one overloaded operator function (you may overload << or >> or any other operator).	**2**
4	Define a class Employees having data members as: employee number, name, date of birth (dd-mm-yyyy), rank, and salary. When an employee is first recruited then all these are given values of 0. Upon confirmation, the actual values of these are entered for the employee. The employee's rank can be incremented by 1 and when this happens an employee gets an increment of 25%.	**2**
5	Students are registered in a University. When students are created then they are given default values (zeroes or blanks) for roll_number, department, year, and semester of study. At registration time, the values of these attributes of student are updated with the proper values. Students can be promoted and their departments can be changed.	**2**
6	Define two classes Distance1 and Distance2. Distance1 stores distance in miles and Distance2 in kmeters & meters. Write a program that reads values of the class objects and adds one object of Distance1 with the object of Distance2 class. The display should be in the format of miles or kmeters & meters depending on the type of object (Distance1 or Distance2) being used to invoke the function. (Hint: Make use of friend function).	**2**
7	Mid-Semester Practical Examination	**2**
8	Imagine a publishing company that markets both books and audio-cassette version of its works. Create a class Publication that stores the title (a string) and price (type float) of a publication. From this class derive two classes: Book, which adds a page count and Tape, which adds playing time in minutes. These classes should have getdata() function to get its data from the user and the putdata() function to display its data. Write a main() program to test the book and tape classes by creating instances of them, asking the user to fill in their data with getdata() and displaying the data with putdata().	**2**
9	Define a class Shape with two pure virtual functions as enterData() and displayArea(). Now, define a classes Rectangle and Circle that inherit the Shape class. Both the classes override and define the pure virtual functions. In the main() method, illustrate the concept of dynamic binding.	**2**
10	Define a class Directory with members: name and phone number. Use the	**2**

	class object to store each set of data into a text file "phone.txt". The names contain only one word and the names and telephone numbers are separated by white spaces. Write a program to read the file and output the list in two columns, such as: John 23456 Denvar 9876 …… ……	
11	Create a class named Student. Data members include the student's roll number, first name, last name, class and the program of study. Member functions include enter() and display() to enter and display the record of the student. In the main() method, write multiple objects of this class into the file stud.txt. There should be an option to search a student's record on the basis of his/her roll number and delete it from the file.	**2**
12	A programmer wants to manipulate arrays. Two arrays are equal if (a) they have the same dimension, (b) are of the same size, and (c) contain identical values in their corresponding elements. Comparison is done using the operator '= =' which returns true or false. Also, arrays can be copied to one another using the operator '='. Define a template function to sort an array of elements of int type, float type, and string type.	**2**
13	Define an exception called "NoMatchException" that is thrown when a string is not equal to "India". Write a program that uses this exception.	**2**
14	End-Semester Practical Examination	**2**
	Total Lab hours	**28**

Evaluation Scheme:

S No	Exam	Coverage/Scope of Examination	Marks
1	Mid Term Test	Viva and Written Exam	20
2	End Term Test	Viva and Written Exam	20
3	Lab Records		15
4	Teacher Assessment	(Quality and quantity of experiment performed, learning laboratory skills)	30
5	Attendance and discipline in lab		15
6	Total		100

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	1	2	2	1	2	2	1	1	1	3	3	**1.75**
CO-2	1	1	3	1	3	3	3	1	2	1	1	3	**1.92**
CO-3	2	2	1	2	1	1	2	3	1	3	2	1	**1.75**
CO-4	1	3	3	3	3	3	1	1	2	1	2	1	**2**
Average	**1.5**	**1.75**	**2.25**	**2**	**2**	**2.25**	**2**	**1.5**	**1.5**	**1.5**	**2**	**2**	

Object Oriented Technologies using Java

COURSE CODE:

COURSE CREDITS: 2

ELECTIVE: OPEN ELECTIVE

L-T-P: 2-0-0

Pre-requisite: Introduction to C Programming

Course Objectives:

Today almost every branch of computer science is feeling presence of object- orientation. Object oriented technology is successfully incorporated in various fields of computer science. Since its arrival on the scene in 1995, the Java has been accepted as one of the primary programming language. This course is designed to give you exposure to basic concepts of object-oriented technology. This course will help in learning to write programs in Java using object-oriented paradigm. Approach in this course is to take Java as a language that is used as a primary tool in many different areas of programming work.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO1	Understanding the features and concepts of Object-Oriented Programming using Java	Familiarity
CO2	Defining classes, objects, constructors, methods in Java	Usage
CO3	Inheritance, Interfaces, and Polymorphism	Usage
CO4	Packages, Exception Handling, and Multithreading	Usage

Course Contents:

S No	Topics	Lectures required
1	Object-Oriented Concepts: Classes and Objects, Abstraction and Encapsulation, Inheritance, and Polymorphism.	2
2	Java Language Basics Introduction To Java, Basic Features, Java Virtual Machine Concepts, A Simple Java Program, Primitive Data Type And Variables, Java Keywords, Integer and Floating Point Data Type, Character and Boolean Types, Declaring and Initialization Variables, Java Operators.	3
3	Expressions, Statements and Arrays Expressions, Statements, Control Statements, Selection Statements, Iterative Statements, Jump Statements, Arrays.	2
4	Class and Objects Class Fundamentals, Creating objects, Assigning object reference variables, Introducing Methods, Static methods,	5

	Constructors, Overloading constructors, This Keyword, Using Objects as Parameters, Argument passing, Returning objects, Method Overloading, Garbage Collection, The finalize () Method.	
5	Strings and Characters Fundamentals of Characters and Strings, The String Class, String Operations, Data Conversion using valueOf() Methods, String Buffer Class and Methods.	2
6	Inheritance and Polymorphism Inheritance Basics, Access Control, Multilevel Inheritance, Method Overriding, Abstract Classes, Polymorphism, Final Keyword.	4
7	Packages and Interfaces Package, Defining Package, CLASSPATH, Package naming, Accessibility of Packages, Using Package Members, Interfaces, Implementing Interfaces, Interface and Abstract Classes, Extends and Implements Together.	3
8	Exceptions Handling Exception, Handling of Exception, Using try-catch, Catching Multiple Exceptions, Using finally clause, Types of Exceptions, Throwing Exceptions, Writing Exception Subclasses	3
9	Multithreaded Programming Multithreading: An Introduction, The Main Thread, Java Thread Model, Thread Priorities, Synchronization in Java, Inter-thread Communication.	4
	Total	**28**

Suggested Text Book(s):

1. Java 2: The Complete Reference, Fifth Edition -- by Herbert Schildt
2. Bruce Eckel, Thinking in Java

Evaluation Scheme:

S No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 hour.	Syllabus covered upto Test-1
2	T-2	25	1.5 hours	Syllabus covered upto Test-2
3	T-3	35	2 hours	Syllabus covered upto Test-3
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) -10 Attendance - 5

Course Outcomes (COs) contribution to the Programmed Outcomes (POs)

Course outcomes	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	1	2	2	1	2	2	1	1	1	3	3	**1.75**
CO-2	1	1	3	1	3	3	3	1	2	1	1	3	**1.92**
CO-3	2	2	1	2	1	1	2	3	1	3	2	1	**1.75**
CO-4	1	3	3	3	3	3	1	1	2	1	2	1	**2**
Average	**1.5**	**1.75**	**2.25**	**2**	**2**	**2.25**	**2**	**1.5**	**1.5**	**1.5**	**2**	**2**	

Object Oriented Technologies using Java Lab

COURSE CODE: XXX
COURSE CREDITS: 1
CORE/ELECTIVE: OPEN ELECTIVE
L-T-P: 0-0-2
Pre-requisite: Introduction to C programming

Course Objectives:

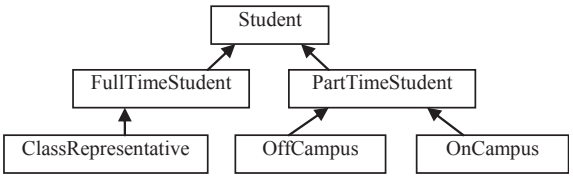
Today almost every branch of computer science is feeling presence of object- orientation. Object oriented technology is successfully incorporated in various fields of computer science. Since its arrival on the scene in 1995, the Java has been accepted as one of the primary programming language. This course is designed to give you exposure to basic concepts of object-oriented technology. This course will help in learning to write programs in Java using object-oriented paradigm. Approach in this course is to take Java as a language that is used as a primary tool in many different areas of programming work.

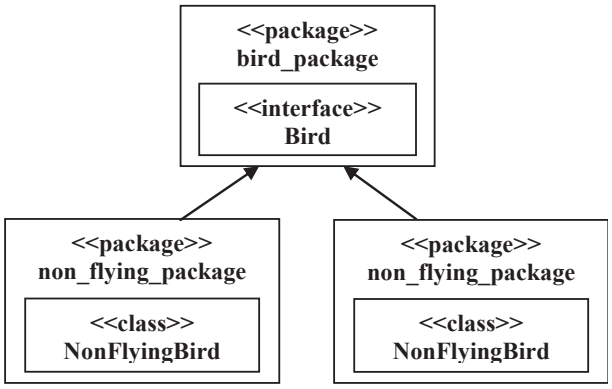
Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO1	Understanding the features and concepts of Object-Oriented Programming using Java	Familiarity
CO2	Defining classes, objects, constructors, methods in Java	Usage
CO3	Inheritance, Interfaces, and Polymorphism	Usage
CO4	Packages, Exception Handling, and Multithreading	Usage

List of Experiments

S No	Description	Hours
1	i. Write a Java program to check if a number is a palindrome in Java. ii. Write a Java program to print following structure. * *** ***** *** *	**2**
2	Write a program in Java to print the Fibonacci series up to a given number? Write both iterative and recursive versions.	**2**
3	Define a class Queue in Java with methods to insert and delete the data (int type) from the queue. The queue must be implemented using array.	**2**
4	Define a class LinkedList in Java with members data of integer type and a reference next of LinkedList type. Define methods to insert and display the elements of the linked list.	**2**

5	Implement a singleton class. A class whose number of instances that can be instantiated is limited to one is called a singleton class. (Hint: make use of static members).	**2**
6	Write a Java program that accepts two strings S1 and S2 as input. The program should check if either of the input strings is a substring of the other and give appropriate message as output.	**2**
7	Mid-Semester Practical Examination	**2**
8	Design and implement the following class hierarchy using Java.  	**2**
9	Define a class named Television in Java that has data members to hold the model number of a television, the screen size in inches, and the price. The class has methods to enter and display the details of the television. The class throws an exception "TelevisionException under the following conditions: • If more than 4 digits are entered for the model number • If the screen size is smaller than 12 inches or greater than 70 inches. • If the price is negative or greater than Rs 50,000.	**2**
10	You may include additional data members in the classes. The class Programme is defined inside the package pack1.pack2, whereas classes FullTime and PartTime are defined inside the package pack1. You should include at least one constructor in each class. All the classes should have two methods as getProgrammeInfo() and printProgrammeInfo() to enter and display all the information of that object, respectively.	**2**
11	Define a class *First* inside a package pack1 with an integer data member *i* and methods to enter and display the value of *i*. Define another class inside a package pack2, which is a sub package of pack1. The class *Second* has a float type data member *f* and methods to enter and display the value of *f*. Now, import both of the above classes and instantiate their objects in the main method. Thereafter, call the methods of both the classes.	**2**
12	Realize the following class diagram using Java.	**2**

		
13	Write a program for generating two threads using Runnable interface. One thread is used for printing the numbers (1 to 26) and the other for printing alphabets (A to Z). Which of the two threads will be executed first (assuming that both of the threads are set to the same priority)?	**2**
14	End-Semester Practical Examination	**2**
	Total Lab hours	**28**

Evaluation Scheme:

S No	Exam	Coverage/Scope of Examination	Marks
1	Mid Term Test	Viva and Written Exam	20
2	End Term Test	Viva and Written Exam	20
3	Lab Records		15
4	Teacher Assessment	(Quality and quantity of experiment performed, learning laboratory skills)	30
5	Attendance and discipline in lab		15
6	Total		100

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	1	2	2	1	2	2	1	1	1	3	3	**1.75**
CO-2	1	1	3	1	3	3	3	1	2	1	1	3	**1.92**
CO-3	2	2	1	2	1	1	2	3	1	3	2	1	**1.75**
CO-4	1	3	3	3	3	3	1	1	2	1	2	1	**2**
Average	**1.5**	**1.75**	**2.25**	**2**	**2**	**2.25**	**2**	**1.5**	**1.5**	**1.5**	**2**	**2**	

Software Testing Methodologies

COURSE CODE:
COURSE CREDITS: 2
CORE/ELECTIVE: OPEN ELECTIVE
L-T-P: 2-0-0

Pre-requisites: C/C++, Python, Eclipse, Netbeans

Course Objectives:

1. Employ correct testing terminology throughout the testing process
2. Execute specific software tests with well-defined objectives and targets.
3. Modelling techniques: UML: FSM and State charts, combinatorial design; and others.
4. Apply various testing techniques, including domain, code, fault, usage and model-based.
5. Perform a complete testing process, taking into account practical considerations**.**

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Investigate the reason for bugs and analyze the principles in software testing to prevent and remove bugs.	Familiarity
CO-2	Implement various test processes for quality improvement.	Assessment
CO-3	Design test planning and manage the test process.	Assessment
CO-4	Apply the software testing techniques in commercial environment.	Assessment
CO-5	Design test adequacy assessment and enhancement criteria.	Assessment
CO-6	Use practical knowledge of a variety of ways to test software and an understanding of some of the tradeoffs between testing techniques.	Usage

Course Contents:

Unit	Contents	Lectures required
1	**Introduction:** Error, Fault, Failure, Test automation and the importance of testing, Developer and tester as two roles, Principles of Testing, ETVX Model, Testing Maturity Model, V-Model, Software quality, Testing and debugging (preparing, Constructing, Executing, Specifying, Assessing a test plan), test Generation Strategies, Types of testing and Classifiers C1, C2, C3, C4, and C5, Static testing **Preliminaries mathematical:** Predicates and Boolean Expressions, Control Flow Graph, Program Dependence Graph, Strings languages and regular expressions,	**4**

2	**Test Generation:** **a) From Domain Partitioning:** The test selection problem, Equivalence partitioning, Boundary value analysis, Category-partition method, Cause-effect graphing. **b) From Finite State Models**: Finite State machines, Conformance testing, A Fault model, Characterization Set, The w-Method, The partial W-methos. **c) From Combinatorial design**: Combinatorial designs, A combinatorial test design process, Fault model, Latin Squares, Mutually orthogonal Latin squares, Pairwise designs: binary factors, Pairwise design: multi-valued factors, Orthogonal Arrays.	**8**
3	**Test Adequacy Assessment and Enhancement:** **a) Using Control flow:** Test adequacy basics, adequacy criteria based on control flow – Statement coverage, Decision coverage, condition coverage, MCC, LCSAJ, basis path coverage, b) **Using data Flow:** Definitions, C-use, p-use, Data flow graphs, du-path, dc-path, c-use coverage, p-use coverage, All-use coverage, k-dr chain coverage. **c) Using Mutation:** Mutation and Mutants, Test Assessment using mutation, Mutation operators, Founding principles of mutation testing, Equivalent mutants, Fault detection using mutation, Types of mutants.	**8**
4	**Phases of testing I:** **Regression testing:** Regression test process, Regression test selection, Selecting regression tests, test selection using execution trace, test selection using dynamic slicing	**4**
5	**Phases of testing II:** Unit Testing, Integration Testing, System testing, Acceptance testing.	**4**
Total lectures		**28**

Suggested Text Book(s):

1. "Foundations of Software testing," 2nd edition by Aditya P mathur, Pearson 2013
2. "Practical Software testing," 8th edition by Ilene Burnstein, Springer 2010

Suggested Reference Book(s):

1. Paul C. Jorgensen, Software testing: a Craft's man approach, CRC Press
2. Srinivasan Desikan and G. Ramesh, Software Testing: Principles and Practices, Pearson Education
3. Glenford Myers, "The Art of Software Testing", John Wiley & Sons Inc., New York, 1979.

4. Cem Kaner, Jack Falk, Nguyen Quoc, "Testing Computer Software", Second Edition, Van Nostrand Reinhold, New York, 1993.
5. Boris Beizer, "Software Testing Techniques", Second Volume, Second Edition, Van Nostrand Reinhold, New York, 1990.
6. Roger S. Pressman, "Software Engineering – A Practitioner's Approach", Fifth Edition, McGraw- Hill International Edition, New Delhi, 2001.
7. Boris Beizer, "Black-Box Testing – Techniques for Functional Testing of Software and Systems", John Wiley & Sons Inc., New York, 1995.
8. K.K. Aggarwal & Yogesh Singh, "Software Engineering", New Age International Publishers, New Delhi, 2003.

Other useful resource(s):

1. Link to NPTEL course contents: https://nptel.ac.in/courses/106105150/
2. Link to topics related to course:
   i. https://www.guru99.com/software-testing.html
   ii. https://www.inf.ed.ac.uk/teaching/courses/st/2011-12/Resource-folder/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment		Entire Semester	Assignment (2) - 1 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Software Testing Fundamentals)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	3	2	2	3	2	2	2	3	1	3	**2.4**
CO-2	3	3	3	2	3	2	3	2	2	3	1	3	**2.5**
CO-3	3	3	3	2	2	3	1	2	3	3	1	3	**2.4**
CO-4	3	3	3	2	3	3	2	2	3	3	1	3	**2.6**
CO-5	3	3	3	2	3	3	2	2	3	3	1	3	**2.6**
CO-6	3	3	3	2	3	3	2	2	2	3	1	3	**2.5**
Average	**3**	**3**	**3**	**2**	**2.7**	**2.8**	**2**	**2**	**2.5**	**3**	**1**	**3**	

Software Testing Methodologies Lab

COURSE CODE: 18B1WCI673

COURSE CREDITS: 1

CORE/ELECTIVE: ELECTIVE

L-T-P: 0-0-2

Pre-requisite: Object Oriented Analysis and Design with UML, Software Engineering, Software Metrics, Basics of Mathematics.

Course Objectives:

1. Have an ability to apply software testing knowledge and engineering methods.
2. Have an ability to design and conduct a software test process for a software testing project.
3. To learn how to planning a test project, design test cases and data, conduct testing operations, manage software problems and defects, generate a testing report.
4. To discuss various software testing issues and solutions in software unit test; integration, regression, and system testing.
5. To gain the techniques and skills on how to use modern software testing tools to support software testing projects.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Have an ability to apply software testing knowledge and engineering methods.	Familiarity
CO-2	Have an ability to design and conduct a software test process for a software testing project.	Usage
CO-3	Have an ability to identify the needs of software test automation, and define and develop a test tool to support test automation.	Assessment
CO-4	Have an ability understand and identify various software testing problems, and solve these problems by designing and selecting software test models, criteria, strategies, and methods.	Assessment
CO-5	Have an ability to use various communication methods and skills to communicate with their teammates to conduct their practice-oriented software testing projects.	Usage
CO-6	Have basic understanding and knowledge of contemporary issues in software testing, such as component-based software testing problems.	Usage
CO-7	Have an ability to use software testing methods and modern software testing tools for their testing projects.	Usage

List of Experiments:

S. No	Description	Hours
1	Revision of Java coding using Eclipse	**2**
2	Developing Black box test cases 1: a) Using Boundary Value Analysis	**2**
3	Developing Black box test cases 2: a) Using Equivalent Classes	**2**
4	Developing Black box test cases 3: a) Using Decision Tables	**2**
5	Developing WhiteBox test cases 1: a) Performing Path testing	**2**
6	Developing WhiteBox test cases 2: a) Performing orthogonal testing	**2**
7	Developing WhiteBox test cases 3: a) Performing Coverage Analysis	**2**
8	Mutation testing and developing Mutants	**2**
9	Regression testing and Developing Regression test Cases	**2**
10	Performing GUI testing for a designed application	**2**
11	Performing Load testing for a designed application	**4**
12	Getting familiar with Profiler and performing CPU, Memory analysis in real time	**4**
	Total Lab Hours	**28**

Suggested Books/Resources:

1. 1. A Practitioner's Guide to Software Test Design, Lee Copeland, 2003,
2. The Art of Software Testing, 2nd edition, Glenford Myers, et. el., 2004
3. Software Testing Techniques, 2nd edition, Boris Beizer, 1990
4. How to Break Software: A Practical Guide to Testing, James Whittaker, 2002.
5. Testing Object-Oriented Systems: Models, Patterns, and Tools, Robert V. Binder, 1999.
6. Software Testing and Quality Assurance: Theory and Practice Paperback – 2010

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Attendance	15 Marks
4	Lab Assessment	45 Marks
	Total	100 marks

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Average
CO-1	3	2	3	2	2	3	3	3	2	3	2	2	**2.5**
CO-2	3	3	3	2	3	3	3	3	2	3	2	3	**2.8**
CO-3	3	3	3	2	2	3	3	3	3	3	2	2	**2.7**
CO-4	3	3	3	3	3	3	3	2	2	3	3	3	**2.8**
CO-5	3	3	3	2	2	2	3	3	3	3	2	2	**2.6**
CO-6	3	3	3	3	3	3	3	2	2	3	3	3	**2.8**
CO-7	3	3	3	3	3	3	2	2	3	3	3	3	**2.8**
Average	**3**	**2.9**	**3**	**2.4**	**2.6**	**2.9**	**2.9**	**2.6**	**2.4**	**3**	**2.4**	**2.6**	

Software Defined Network

COURSE CODE: XXX

COURSE CREDITS: 3

CORE/ELECTIVE: OPEN ELECTIVE

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

- To understand the fundamentals of software defined networks.
- To understand the separation of the data plane and the control plane.
- To study about the SDN Programming.
- To study about the various applications of SDN

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Analyze the evolution of software defined networks	Familiarity
CO-2	Express the various components of SDN and their uses	Assessment
CO-3	Explain the use of SDN in the current networking scenario	Assessment
CO-4	Design and develop various applications of SDN	Usage

Course Contents:

Unit	Contents	Lectures required
1	**Introduction:** Basic Packet-Switching Terminology, Historical Background, The Modern Data Center, Traditional Switch Architecture, Autonomous and Dynamic Forwarding Tables. Open Source and Technological Shifts	7
2	**Why SDN?:** Evolution of Switches and Control Planes, Cost, SDN Implications for Research and Innovation, Data Center Innovation, Data Center Needs	7
3	**The Genesis of SDN :**The Evolution of Networking Technology, Forerunners of SDN, Software Defined Networking is Born., Sustaining SDN Interoperability, Open Source Contributions. Legacy Mechanisms Evolve Toward SDN, Network Virtualization	7

4	**How SDN Works:** Fundamental Characteristics of SDN, SDN Operation, SDN Devices, SDN Controller, SDN Applications, Alternate SDN Methods.	**7**
5	**The Open Flow Specification:** Open Flow Overview, Open Flow 1.0 and Open Flow Basics, Open Flow Limitations.	**7**
6	**Alternative Definitions of SDN and SDN in Other Environments:** SDN via APIs, SDN via Hypervisor-Based Overlays, SDN in Data Center, Wide Area Networks, Campus Networks, Hospitality Networks, Mobile Networks	**7**
	Total lectures	**42**

Suggested Text Book(s):

- Paul Goransson and Chuck Black, Software Defined Networks: A Comprehensive Approach, First Edition, Morgan Kaufmann, 2014.
- Thomas D. Nadeau, Ken Gray, SDN: Software Defined Networks, O'Reilly Media, 2013.

Suggested Reference Book(s):

- Siamak Azodolmolky, Software Defined Networking with Open Flow, Packet Publishing, 2013.
- Vivek Tiwari, SDN and Open Flow for Beginnersll, Amazon Digital Services, Inc., 2013.
- Fei Hu, Editor, Network Innovation through Open Flow and SDN: Principles and Design, CRC Press, 2014.

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programmed Outcomes (POs)

Course Outcomes	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	1	2	2	2	3	1	1	1	1	2	2	3	**1.75**
CO-2	3	3	2	2	2	2	2	1	2	2	1	2	**2**
CO-3	3	1	2	1	2	2	2	2	2	3	1	1	**1.83**
CO-4	3	3	2	2	2	2	1	2	1	2	2	1	**1.91**
Average	**2.5**	**2.25**	**2**	**1.75**	**2.25**	**1.75**	**1.5**	**1.5**	**1.5**	**2.25**	**1.5**	**1.75**	

Introduction to Statistical Learning

COURSE CODE: XXX

COURSE CREDITS: 3

CORE/ELECTIVE: OPEN ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Basics of programming and mathematics.

Course Objectives:

- To understand the fundamentals of statistical learning and, analyzing regression and classification.
- To understand and analyze pre-processing data and model selection.
- To understand and analyze non-linear and tree based regression.
- To understand and analyze Support Vector Classifier and Machines, and unsupervised learning.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Understanding statistical learning and, analyzing regression and classification.	Familiarity and usage
CO-2	Analyzing resampling, model selection and regularization.	Usage
CO-3	Analyzing non-linear and tree based regression.	Usage
CO-4	Analyzing Support Vector Machines and unsupervised learning	Usage

Course Contents:

Unit	Contents	Lectures required
1	**Introduction to statistical learning:** Prediction accuracy, Model interpretability, Supervised and Unsupervised learning, Assessing model accuracy	**6**
2	**Regression and Classification:** Regression- Linear, MultiLinear and kNN, Classification-Logistic regression, Linear and quadratic discriminant analysis, and kNN	**8**
3	**Resampling, Model Selection and Regularization:** Cross-validation, the bootstrap, Subset selection, Shrinkage methods, Dimension reduction methods, considerations in high dimension	**8**

4	**Non-linear Regression:** Polynomial regression, Step functions, Regression splines, Smoothing splines, Local regression, Generalized additive methods, **Tree Based Regression:** the basics of decision trees, Bagging, Random forest and Boosting,	**10**
5	**Support Vector Machines:** Maximal margin classifier, Support Vector Classifier and Support Vector Machines, **Unsupervised Learning:** The challenges, Principal Component Analysis, Clustering methods	**10**
	Total lectures	**42**

Suggested Text Book(s):

- Gareth James, Daneila Witten, Trevor Hastie and Robert Tibshirani, "An Introduction to Statistical Learning with Applications in R", Springer, 8th Printing, 2017.

Suggested Reference Book(s):

- Hastie, Tibshirani and Friedman, "The elements of statistical learning", 2nd edition, Springer, 2009.
- Sanjeev Kulkarni and Gilbert Harman, " An elementary introduction to statistical learning theory, Wiley, 2011.
- Fernandes de Mello, Rodrigo et. al., " Machine Learning – A practical approach on the statistical learning theory", Springer, 2018.

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programmed Outcomes (POs)

Course Outcomes	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	3	3	3	3	1	1	2	1	3	2	**2.33**
CO-2	3	3	3	3	3	3	2	1	2	1	3	2	**2.42**
CO-3	3	3	3	3	3	3	2	1	2	1	3	2	**1.42**
CO-4	3	3	3	3	3	3	1	1	2	1	3	2	**2.33**
Average	**3**	**3**	**3**	**3**	**3**	**3**	**1.5**	**1**	**3**	**1**	**3**	**3**	

Principles of Distributed Database Systems

COURSE CODE: XXX

COURSE CREDITS: 3

CORE/ELECTIVE: OPEN ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Database management Systems

Course Objectives:

To introduce the fundamental concepts and design issues of managing large volume of shared data in distributed environment, and to provide insight into related research problems.

- To understand the fundamentals of Distributed Database Systems.
- To understand the various database designing processes.
- To study about the query processing and query optimization in a distributed environments.
- To study about the various applications of distributed databases.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Understand the fundamentals of Distributed Database Systems (DDBMS), including its design and architecture	Familiarity
CO-2	Understand the concept of data integration design process	Assessment
CO-3	Gain skill about query processing & optimization in distributes environment	Assessment
CO-4	Explain the use of Distributed database system in real life applications	Usage
CO-5	Implement applications/tools in order to utilize DDBMS applications.	Usage

Course Contents:

Unit	Contents	Lectures required
1	**Introduction:** Distributed Data Processing, What is a Distributed Database System? Data Delivery Alternatives, Promises of DDBSs, Complications Introduced by Distribution, Design Issues, Distributed DBMS Architecture,	4

2	**Distributed Database Design:** Top-Down Design Process, Distribution Design Issues, Fragmentation, Allocation, Data Directory	7
3	**Database Integration:** Bottom-Up Design Methodology, Schema Matching, Schema Integration, Schema Mapping, Data Cleaning	7
4	**Overview of Query Processing:** Query Processing Problem, Objectives of Query Processing, Complexity of Relational Algebra Operations, Characterization of Query Processors, Layers of Query Processing, Query Decomposition, Localization of Distributed data	6
5	**Optimization of Distributed Queries:** Query Optimization, Centralized Query Optimization, Join Ordering in Distributed Queries, Distributed Query Optimization	6
6	**Multidatabase Query Processing:** Issues in Multidatabase Query Processing, Multidatabase Query Processing Architecture, Query Rewriting Using Views, Query Optimization and Execution, Query Translation and Execution	6
7	**Dataspace System:** Introduction, Pay-as-you-go data integration, Design issues, Data modeling, Query processing and answering, Entity resolution, Users feedback in Dataspace System, Indexing dataspaces, Source Discovery	6
	Total lectures	**42**

Suggested Text Book(s):

- Principles of Distributed Database Systems, M. Tamer Ozsu, Patrick Valduriez , Springer, 2011, ISBN 978-1-4419-8833-1.
- Distributed Database Management Systems- A Practical Approach, Saeed K Rahimi, Frank S Haug, Wiley Publication, 2010, ISBN 978-0-470-40745-5

Suggested Reference Book(s):

1. Distributed Database Mangement Systems, Rahimi & Haug, Wiley
2. Distributed Database Systems, Chanda Ray, Pearson Publication
3. Additional research papers from the literature may be assigned as reading material.

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) – 10 Quizzes (2) - 10 Attendance – 5

Course Outcomes (COs) contribution to the Programmed Outcomes (Pos)

Course outcomes (Software Defined Network)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	3	2	2	3	2	2	2	3	1	3	**2.4**
CO-2	3	3	3	2	3	2	3	2	2	3	1	3	**2.5**
CO-3	3	3	3	2	2	3	1	2	3	3	1	3	**2.4**
CO-4	3	3	3	2	3	3	2	2	3	3	1	3	**2.6**
CO-5	3	3	3	2	3	3	2	2	3	3	1	3	**2.6**
Average	**3**	**3**	**3**	**2**	**2.6**	**2.8**	**2**	**2**	**2.6**	**3**	**1**	**3**	

Foundations of Block Chain

Course Code: XXX

Course Credit: 3-0-0

Course Pre-requisites (if any): Some programming experience (at least one year suggested). Potential students will need to pass a brief programming assessment for enrollment in the course.

Course Objectives:

S No	Course Outcomes (Block Chain Technologies) 18B1WCI836	Level of Attainment
CO-1	Explain how bitcoin works, from when a transaction is created to when it is considered part of the blockchain	Familiarity
CO-2	Thoroughly explain private and public keys as well as addresses and how exactly they are constructed and used	Familiarity
CO-3	Expose students to the different kinds of forking and explain the Bitcoin's network mechanisms for maintaining and upgrading	Assessment
CO-4	Decompose a blockchain system's fundamental components, how they fit together and examine a modular blockchain system in more detail	Assessment
CO-5	Detailed understanding of naïve Attacks and Trustless Networks of block chain	Assessment
CO-6	Provide a thorough understanding of smart contracts, their technical capabilities, practical applications, limitations and security constraints they operate within	Usage
CO-7	Explain to students both fundamental and implied differences between Ethereum and Bitcoin protocol by covering historical, conceptual and architectural distinctions	Assessment

Detailed Course Contents:

Module	Contents	Lectures required
Module-1	**The story of a transaction** a) From Transactions to Blocks b) Blocks and Distributed Consensus c) Basic interaction with a Bitcoin node	**2**
Module-2	**Keys and Addresses** a) Basic cryptography b) From private keys to addresses	**2**
Module-3	**The Bitcoin Script language** a) Introduction to the Bitcoin Script language b) Script writing and execution c) Advanced scripting	**8**

	d) Tools and libraries to access Bitcoin's API and scripting capabilities **Blockchain deployment** a) Mining and forking b) Upgrading the network c) Related BIPs d) Segregated Witness (SegWit)	
Module-4	**Blockchain architectures** a) Abstract Architecture b) Ways to dive deeper c) Introduction to major blockchain platforms	**6**
Module-5	**Comparing Bitcoin and Ethereum** a) Historical comparison b) Conceptual distinction between a payment system and a decentralized applications platform c) Differences in their architectures from *security-first aspect to a rich feature set* d) Future roadmap for them, following their own paths with probable interconnections	**8**
Module-6	**Development environment** a) Multitude of clients in Ethereum b) Production and test networks in Ethereum c) *Public, private and development deployments* **Contract code walk-through** a) Demonstration of smart contract b) Introduction to Solidity c) Contract lifecycle	**8**
Module-7	**Solidity in depth** a) Building blocks b) Popular contracts already in deployment **Considerations for production deployment** a) Quality of decentralized applications b) Code patterns c) *Security* d) Other smart contract platforms e) Discussion of future prospects	**8**
	TOTAL LECTURES	**42**

Suggested Text Book(s):

- Mastering Bitcoin, Andreas Antonopoulos, O'Reilly Publishing, 2014, ISBN: 978-0691171692.
- Bitcoin: A Peer-to-Peer Electronic Cash System, Satoshi Nakamoto, Online 2009 https://bitcoin.org/bitcoin.pdf
- Vitalik Buterin, Ethereum White Paper, Online, 2017, https://github.com/ethereum/wiki/wiki/ White- Paper

Suggested Reference Book(s):

- Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction, A. Narayanan, J.
- Bonneau, E. Felten, A. Miller, S. Goldfeder, Princeton University Press, 2016, ISBN: 978-0691171692
- The Science of the Blockchain, Roger Wattenhofer, CreateSpace Independent Publishing Platform, 2016, ISBN: 978-1522751830
- Ethereum Programming, Alex Leverington, Packt Publishing Limited, 2017, ISBN: 978- 1786463715

Other useful resource(s):

- Bitcoin Protocol Specifications (https://en.bitcoin.it/wiki/Protocol_specification)
- Bitcoin transaction Scripting (https://en.bitcoin.it/wiki/Script)
- Majority is not Enough: Bitcoin Mining is Vulnerable (http://arxiv.org/abs/1311.0243)
- Two Bitcoins at the Price of One? Double-Spending Attacks on Fast Payments in Bitcoin (http://eprint.iacr.org/2012/248.pdf)
- Ethereum documentation (http://www.ethdocs.org/en/latest)
- Solidity documentation ((https://solidity.readthedocs.io/en/develop))
- https://sites.google.com/site/blockchaintutorial/blockchain-course-content

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) – 10 Quizzes (2) - 10 Attendance – 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Weightage
CO-1	3	2	3	2	2	3	2	3	2	2	3	3	83
CO-2	3	2	3	2	2	3	3	2	2	3	3	3	86
CO-3	2	2	2	2	2	3	3	3	2	2	3	3	81
CO-4	3	2	3	2	3	2	2	3	3	3	2	2	83
CO-5	3	2	2	2	3	2	2	2	2	3	3	3	81
CO-6	2	3	3	3	3	2	3	2	2	3	3	2	86
CO-7	2	2	2	2	2	3	3	3	2	2	3	3	81
Weightage	86	71	86	71	81	86	86	86	71	86	95	90	

Computational Biology

COURSE CODE: XXX

COURSE CREDITS: 3

ELECTIVE: OPEN ELECTIVE

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

- To understand the fundamentals of Computational Molecular Biology.
- To understand the computational methods for biological sequence analysis.
- To study about the dynamic programming for sequence alignments, methods for genomics and structural bioinformatics.
- To study about the various applications of computer science techniques in computational biology.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Fundamentals of Computational Molecular Biology	Familiarity
CO-2	Express the use of computational methods for biological sequence analysis	Assessment
CO-3	Explain the use of sequence alignments, methods for genomics and structural bioinformatics	Assessment
CO-4	Applications of computer science techniques in computational biology	Usage

Course Contents:

Unit	Contents	Lectures required
1	**Introduction:** Basic knowledge of molecular biology including DNA, RNA, Proteins and Genetic code systems. Biological sequences types and data. Computers in biology, medicine and healthcare.	**5**
2	**Biological Databases:** Evolution of biological databases. Collection, storage and analysis of biological data through	**4**

	biological databases. Sequence formats and storage, Access databases, limitations of existing databases.	
3	**Sequence Alignment and Analysis:** Local alignment, Global alignment, Scoring matrices - PAM, BLOSUM, Gaps and penalties, Dot plots. Dynamic programming approach: Needleman and Wunsch Algorithm, Smith and Waterman Algorithm, Hidden Markov Model: Viterbi Algorithm. Heuristic approach: BLAST, FASTA. Building Profiles, Profile based functional identification.	**7**
4	**Computational Genomics:** Introduction to Next Generation Sequencing technologies. Annotations through Functional and comparative genomics approaches, Human genome project. GWAS, ENCODE, HUGO projects. Personalized and precision medicines. **Software tools in Biology:** Visualization tools including Artemis and Vista for genome comparison. Applications of Grid computing in Biology. Compute Clusters and nature of problems dealt with them.	**10**
5	**Algorithms in Computational Biology:** Whole Genome Assembly and challenges, Fragment assembly algorithms, semi-global alignment, exon chaining and spliced algorithms, brute force, median string and other motif finding algorithms. Recent algorithms for MSA.	**6**
6	**Chemoinformatics:** Introduction, representing 2D & 3D structures, 2D chemical database applications & molecular descriptors and their classifications, database searching and applications in computer aided drug design.	**5**
7	**Quantitative structure activity relationship (QSAR)**: QSAR methodology, biological and physicochemical parameters, feature selection (PLS, PCA, MLR, etc.), model building and validation, QSAR applications in drug design, Quantitative structure-property relationships (QSPR), CoMFA, 3D and nD-QSAR methods.	**5**
	Total lectures	**42**

Suggested Text and Reference Book(s):

1. Dan E. Krane and Michael L. Raymer, 'Fundamental concepts of Bioinformatics', Pearson Education (low Priced Edition).
2. Claverie & Notredame, 'Bioinformatics - A Beginners Guide', Wiley- Dreamtech India Pvt Ltd.
3. J. Pevnezer, 'Bioinformatics and functional genomics', John Wiley.
4. David Mount, Bioinformatics: sequence and Genome Analysis, Latest Edition. Cold Spring Harbour Labortory Press.
5. Discovering Genomics, Proteomics and bioinformatics, 2/E by A. Malcolm Campbell and Laurie J.Heyer, Publisher:Benjamin Cummings.

6. ICRF handbook of genome analysis, by NK Spurr, BD Young, SP Bryant. Volumes I & II. - Blackwell science publishers.
7. Isaac S. Kohane, Alvin T. Kho, Atul J. Butte Microarrays for an Integrative Genomics, MIT Press.
8. Philip E. Bourne, Jenny Gu, Structural Bioinformatics, Wiley Blackwell Publisher.

Evaluation Scheme:

S No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programmed Outcomes (POs)

Course Outcomes	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	1	2	2	2	3	1	1	1	1	2	2	3	**1.75**
CO-2	3	3	2	2	2	2	2	1	2	2	1	2	**2**
CO-3	3	1	2	1	2	2	2	2	2	3	1	1	**1.83**
CO-4	3	3	2	2	2	2	1	2	1	2	2	1	**1.91**
Average	**2.5**	**2.25**	**2**	**1.75**	**2.25**	**1.75**	**1.5**	**1.5**	**1.5**	**2.25**	**1.5**	**1.75**	

Multimedia Systems and Applications

COURSE CODE: XXX

COURSE CREDITS: 3

CORE/ELECTIVE: OPEN ELECTIVE

L-T-P: 3-0-0

Pre-requisites: Computer Networks, Operating Systems, Data Structure, Java Programming, Linear Algebra, Web Technology (Those who are simultaneously registered in some of these courses can also take this course.)

Course Objectives:

- fundamentals of multimedia systems
- basic concepts related to multimedia communication.
- the evolution, latest trends, and state-of-the-art in multimedia technology, standards, and applications

  Overall, the aim of the course would be to cover all aspects related to multimedia systems and applications ranging from basic concepts and fundamentals to more advanced discussions on the state-of-the-art in this field..

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Demonstrate mastery of scripting in a multimedia development environment.	Familiarity
CO-2	Create multi-user multimedia applications.	Assessment
CO-3	Create an image/audio/video multimedia application.	Assessment
CO-4	Apply image-processing algorithms to multimedia content within a scripting environment.	Assessment
CO-5	Apply current standards and guidelines for multimedia application development and delivery	Usage

Course Contents:

Unit	Contents	Lectures required
1	**Introduction to Multimedia System and Processing** Introduction to Multimedia, Application Areas, Interdisciplinary Aspects of Multimedia, Multimedia Data representations, Multimedia Data Encoding (Audio, Image, Video and Animation),	**6**

2	**Multimedia Compression Basics** Concept of data compression in multimedia field, lossless techniques (Huffman Coding, Arithmetic and Lempel-Ziv Coding, Other Coding Techniques) and lossy compression techniques (Transform Coding & K-L Transforms, Discrete Cosine Transforms, and BTC), Multi-Resolution Analysis, and Still Image Compression Standards (JBIG and JPEG), Color image processing.	**12**
3	**Audio and Video Processing:** Basics of digital audio, quantization and transmission of Audio. Audio compression, Audio MPEG, Video Coding Standards (MPEG video coding, MPEG4, 7, and beyond).	**6**
4	**Media Server & Networks :** Media Server Architecture, Storage Management, Services, Protocols, Layers, Requirements to Services and Protocols, Layers of the ISO-OSI Model, ATM Networks, Traditional network protocols and their support for Multimedia, Traditional transport protocols and their support for Multimedia, New protocols for transport of multimedia	**6**
5	**Quality of Service & Multimedia Operating System** Requirements and Constraints, Quality of Services Concept, Resource Management, Establishment Phase (QoS Translation, QoS Scaling, QoS Routing, Admission Control), Run-time Phase of Multimedia Call, Process Management, Inter process Communication and Synchronization, Memory Management, Device Management.	**6**
6	**Multimedia Applications:** Case studies	**6**
	Total lectures	**42**

Suggested Text Book(s):

- Ralf Steinmetz, Klara Nahrstedt. Multimedia Systems, Springer, Springer International Edition, (Textbook)
- Fundamentals of Multimedia: Ze-Nian Li & Mark S. Drew, Pearson Prentice Hall, 2004

Suggested Reference Book(s):

- John. F. Koegel Buford. Multimedia Systems. Pearson Education.
- Robert Reinhardt and Joey Lott. Flash MX Action Script Programming. Wiley.
- James E. Shuman. Multimedia in Action. Cengage Learning.
- Khalid Shayood, Data Compression.

Other useful resource(s):

- IEEE Transactions on Multimedia Systems.
- Multimedia Systems (ACM Press)
- ACM SIGMM conference

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment		Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course Outcomes	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	3	2	2	3	2	2	2	3	1	3	**2.4**
CO-2	3	3	3	2	3	2	3	2	2	3	1	3	**2.5**
CO-3	3	3	3	2	2	3	1	2	3	3	1	3	**2.4**
CO-4	3	3	3	2	3	3	2	2	3	3	1	3	**2.6**
CO-5	3	3	3	2	3	3	2	2	3	3	1	3	**2.6**
Average	**3**	**3**	**3**	**2**	**2.6**	**2.8**	**2**	**2**	**2.6**	**3**	**1**	**3**	

Course Description of Proficiency Curricula for B. Tech (CSE) and B. Tech (IT).

Statistics and Data Science

COURSE CODE: XXXXXXXX
COURSE CREDITS: 2
CORE/ELECTIVE: ELECTIVE
L-T-P: 2-0-0

Pre-requisite: Basic knowledge of High School Mathematics and reasonable programming experience.

Course Objectives:

1. Understand the Fundamentals of Statistics
2. Understand the Probability for Data Analysis
3. Learn how to work with Different Types of Data
4. Different Types of Distributions
5. Apply Statistical Methods and Hypothesis Testing to Business Problems
6. Understand all the concepts of Statistics for Data Science and Analytics
7. Working of Regression Analysis
8. Implement one way and two way ANOVA
9. Chi-Square Analysis
10. Central Limit Theorem

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	Understand all the concepts of Statistics for Data Science and Analytics	Familiarity
CO-2	Compute the probabilities of events along with an understanding of the random variables, expectation, variance, and distributions.	Usage
CO-3	Identify probability distributions commonly used as foundations for statistical modeling.	Assessment
CO-4	Apply Statistical Methods and Hypothesis Testing to Business Problems	Usage
CO-5	Broaden the knowledge about Random Variables, Joint Distributions, Special Distributions	Assessment
CO-6	To have hands-on skills on Illustrative example for data analysis(Implementation of statistical techniques, data interpretation, Regression Analysis, Covariance, Hypothesis testing and analysis of variance)	Usage

Course Contents:

Unit	Contents	Lectures Required
1	**Introduction:** What is Data Science? - Big Data and Data Science hype – and getting past the hype - Why now? – Datafication - Current landscape of perspectives - Skill sets needed **Probability:** Classical, relative frequency, and axiomatic definitions of probability, addition rule and conditional probability, multiplication rule, total probability, Bayes' Theorem and independence, problems.	4
2	**Random Variables:** Discrete, continuous, and mixed random variables, probability mass, probability density, and cumulative distribution functions, mathematical expectation, moments, probability and moment generating function, median, and quantiles, Markov inequality, Chebyshev's inequality, problems, Function of a random variable, problems.	5
3	**Special Distributions:** Discrete uniform, binomial, geometric, negative binomial, hypergeometric, Poisson, continuous uniform, exponential, gamma, Weibull, Pareto, beta, normal, lognormal, inverse Gaussian, Cauchy, double exponential distributions, reliability and hazard rate, reliability of series and parallel systems, problems.	4
4	**Joint Distributions:** Joint, marginal and conditional distributions, product moments, correlation and regression, independence of random variables, bivariate normal distribution, problems**.**	4
5	**Sampling Distributions:** The Central Limit Theorem, distributions of the sample mean and the sample variance for a normal population, Chi-Square, t and F distributions, problems	5
6	**Testing of Hypotheses:** Null and alternative hypotheses, the critical and 8 acceptance regions, two types of error, power of the test, the most powerful test and Neyman-Pearson Fundamental Lemma, tests for one sample and two sample problems for normal populations, tests for proportions, Chisquare goodness of fit test and its applications, problems.	6
	Total Lecture Hours	28

Suggested Text Book(s):

- An Introduction to Probability and Statistics by V.K. Rohatgi & A.K. Md. E. Saleh, Wiley, (2008), 3rd ed.
- Introduction to Probability and Statistics by J.S. Milton & J.C. Arnold, Boston, London, McGraw-Hill, (2006), 4th ed.
- Data Science and analytics with python by Jesus Rogel-Salazar.

Suggested Reference Book(s):

- Introduction to Probability Theory and Statistical Inference by H.J. Larson, John Wiley & Sons, (2005) 3rd ed.

- Introduction to Probability and Statistics for Engineers and Scientists by S.M. Ross, Elsevier, (2014), 4th ed.
- Python Data Science Handbook by Jake VanderPlas, 2017.

Other useful resource(s):

- https://nptel.ac.in/courses/110/106/110106064/
- https://onlinecourses.nptel.ac.in/noc18_cs28/preview
- https://bit.ly/2GvlBfs
- https://bit.ly/3aONiOo

Evaluation Scheme:

S No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course Outcomes (Statistics and Data Science)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	1.8
CO-2	2	3	3	3	3	1	1	1	2	2	1	1	1.9
CO-3	2	2	2	2	1	1	1	1	2	2	1	2	1.6
CO-4	3	3	3	3	2	1	1	1	2	3	3	2	2.3
CO-5	2	3	3	3	1	1	1	1	2	3	2	2	2
CO-6	2	3	3	3	2	1	1	1	2	3	2	2	2.1
Average	2.2	2.7	2.7	2.7	1.8	1	1	1	2	2.5	1.8	1.8	1.9

Statistics and Data Science Lab

COURSE CODE: XXXXXXXX

COURSE CREDITS: 1

CORE/ELECTIVE: ELECTIVE

L-T-P: 0-0-2

Pre-requisite: Basics of programming in R or Python

Course Objectives:

1. Understand the fundamentals of statistics and apply them in practice
2. To analyze the data using different descriptive measures and present graphically.
3. Compute the probabilities of events along with an understanding of the random variables, expectation, variance and distributions.
4. Understand the estimation of mean and variance and their respective one-sample and k sample hypothesis tests.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO1	Understand basics of Python or R syntax, functions and programming	Familiarity
CO2	Learn the core tools for data science with R or Python	Usage
CO3	Understand and carry out regression analysis	Usage
CO4	Visualize data: plot different types of data & draw insights	Usage
CO5	Hypothesis testing in R or Python	Usage
CO6	Analyze the systems using Laplace transform and Z-transform.	Usage

List of Experiments

S. No.	Description	Hours
1	Introduction to the basics of Python or R syntax, functions, and programming.	**2**
2	Introduction various packages are available for statistical analysis. (e.g. “stats” package in R, Lib/statistics.py package in python)	**2**
3	Implementation of statistical techniques using statistical packages.	**2**
4	Evaluation of Statistical Parameters and data interpretation	**2**
5	Regression Analysis	**2**
6	Covariance Analysis	**2**
7	Hypothesis testing	**2**
8	Analysis of variance	**2**
9	Introduction to Numpy in Python	**2**
10	Data Manipulation with Pandas	**2**
11	Data Visualization with Matplotlib	**2**
12	Introduction to Data Preprocessing	**2**
13	Introduction to Machine Learning Models	**2**

14	Introduction to model cross-validation and model performance analysis	**2**
	Total Lab Hours	**28**

Suggested/Resources:

- Python Data Science Handbook by Jake VanderPlas, 2017.
- Data Science and analytics with python by Jesus Rogel-Salazar.
- Introduction to Probability Theory and Statistical Inference by H.J. Larson, John Wiley & Sons, (2005) 3rd ed.
- https://bit.ly/3aONiOo
- https://bit.ly/2GvlBfs
- https://bit.ly/2uIJuxg

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Project-1	10 Marks
4	Lab Assessment	45 Marks
5	Lab Attendance	5 Marks
	Total	100 marks

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Avg
CO1	3	3	3	3	2	2	1	1	1	1	1	1	1.8
CO2	3	3	3	3	3	1	1	1	1	1	1	3	2
CO3	3	3	2	3	2	3	2	1	1	1	2	1	2
CO4	3	3	3	2	3	2	1	1	1	1	1	1	1.8
CO5	2	2	3	3	3	3	1	1	1	1	1	1	1.8
CO6	2	3	3	3	2	2	2	2	2	2	2	2	2.3
Avg	2.7	2.8	2.8	2.8	2.5	2.2	1.3	1.2	1.2	1.2	1.3	1.5	2

Digital Forensics

COURSE CODE: XXXXXXXX
COURSE CREDITS: 2
CORE/ELECTIVE: ELECTIVE
L-T-P: 2-0-0
Pre-requisite: Cryptography and Security, Computer Networks

Course Objectives:

1. To understand underlying principles and many of the techniques associated with digital forensic practices and cybercrime
2. To explore practical knowledge about ethical hacking Methodology.
3. To learn the importance of evidence handling and storage for various devices
4. To develop an excellent understanding of current cybersecurity issues (Computer Security Incident) and analyzed the ways that exploit insecurities.
5. To investigate attacks, IDS .technical exploits and router attacks and "Trap and Trace" computer networks.
6. To apply digital forensic knowledge to use computer forensic tools and investigation report writing

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	Introduction to Cyber Crime and Ethical Hacking	Familiarity
CO-2	Introduction to Digital Forensics and Digital Evidences	Familiarity
CO-3	Computer Security Incident Response Methodology	Assessment
CO-4	Forensic Duplication and Disk Analysis, and Investigation Data Analysis	Assessment
CO-5	Network Forensics Incidents, Using Routers as Response Tools	Usage
CO-6	Forensic Investigation Report and Forensic Tools	Usage

Course Contents:

Unit	Contents	Lectures Required
1	Introduction of Cybercrime: Types of cybercrime, categories of cybercrime, Computers' roles in crimes, Prevention from Cybercrime, Hackers, Crackers, Phreakers Ethical Hacking: Difference between Hacking and Ethical hacking: Steps of Ethical Hacking, Exploring some tools for ethical hacking: reconnaissance tools, scanning tools	5
2	Digital Forensic, Rules for Digital Forensic The Need for Digital Forensics, Types of Digital Forensics, Ethics in Digital Forensics,	5

	Digital Evidences: Types and characteristics and challenges for Evidence Handling	
3	Introduction to Computer Security Incident Goals of Incident Response, Incident Response Methodology, Formulating Response Strategy, IR Process – Initial Response, Investigation, Remediation, Tracking of Significant, Investigative Information, Reporting Pre Incident Preparation, Incident Detection, and Characterization. Live Data Collection: Live Data Collection on Microsoft Windows Systems: Live Data Collection on Unix-based Systems	**5**
4	Forensic Duplication Forensic Image Formats, Traditional Duplication, Live System Duplication, Forensic Duplication tools Disk and File System Analysis: Media Analysis Concepts, File System Abstraction Model The Sleuth Kit: Installing the Sleuth Kit, Sleuth Kit Tools Partitioning and Disk Layouts: Partition Identification and Recovery, Redundant Array of Inexpensive Disks Special Containers: Virtual Machine Disk Images, Forensic Containers Hashing, Carving: Foremost, Forensic Imaging: Deleted Data, File Slack, Data Analysis, Analysis Methodology Investigating Windows systems, Investigating UNIX systems, Investigating Applications, Web Browsers, Email, Malware Handling: Static and Dynamic Analysis	**5**
5	Technical Exploits and Password Cracking, Introduction to Intrusion Detection systems, Types of IDS Understanding Network intrusion and attacks, Analyzing Network Traffic, Collecting Network-based evidence, Evidence Handling. Investigating Routers, Handling Router Table Manipulation Incidents, Using Routers as Response Tools	**4**
6	Report: Goals of Report, Layout of an Investigative Report, Guidelines for Writing a Report, sample for writing a forensic report. Computer Forensic Tools: need and types of computer forensic tools, tasks performed by computer forensic tools. Study of open-source Tools like SFIT, Autopsy, etc. to acquire, search, analyze and store digital evidence	**4**
	Total Lecture Hours	**28**

Suggested Text Book(s):

- Jason Luttgens, Matthew Pepe, Kevin Mandia, "Incident Response and computer forensics",3rd Edition Tata McGraw Hill, 2014.
- Nilakshi Jain, Dhananjay Kalbande, "Digital Forensic: The fascinating world of Digital Evidences " Wiley India Pvt Ltd 2017.
- Cory Altheide, Harlan Carvey "Digital forensics with open source tools "Syngress Publishing, Inc. 2011.
- Chris McNab, Network Security Assessment, By O'Reilly.

Suggested Reference Book(s):

- Clint P Garrison "Digital Forensics for Network, Internet, and Cloud Computing A forensic evidence guide for moving targets and data , Syngress Publishing, Inc. 2010
- Bill Nelson,Amelia Phillips,Christopher Steuart, "Guide to Computer Forensics and Investigations" . Cengage Learning, 2014
- Debra Littlejohn Shinder Michael Cross "Scene of the Cybercrime: Computer Forensics Handbook", 2nd Edition Syngress Publishing, Inc.2008.
- Marjie T. Britz, Computer Forensics and Cyber Crime, Pearson, Third Edition.

Evaluation Scheme:

S No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	1.8
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	2
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	1.8
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	2.1
CO-5	2	2	2	2	3	1	1	1	2	2	1	2	1.8
CO-6	2	3	3	3	2	1	1	1	2	3	2	2	2.1
Average	2	2.5	2.5	2.5	2.5	1	1	1	2	2.3	1.5	2	1.9

Digital Forensics Lab

COURSE CODE: XXXXXXXX
COURSE CREDITS: 1
CORE/ELECTIVE: ELECTIVE
L-T-P: 0-0-2
Pre-requisite: Cryptography and Security, Computer Networks

Course Objectives:

1. To understand underlying principles and many of the techniques associated with digital forensic practices and cybercrime
2. To explore practical knowledge about ethical hacking Methodology.
3. To learn the importance of evidence handling and storage for various devices
4. To develop an excellent understanding of current cybersecurity issues (Computer Security Incident) and analyzed the ways that exploit insecurities.
5. To investigate attacks, IDS .technical exploits and router attacks and "Trap and Trace" computer networks.
6. To apply digital forensic knowledge to use computer forensic tools and investigation report writing

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	Introduction to Cyber Crime and Ethical Hacking	Familiarity
CO-2	Introduction to Digital Forensics and Digital Evidences	Familiarity
CO-3	Computer Security Incident Response Methodology	Assessment
CO-4	Forensic Duplication and Disk Analysis, and Investigation Data Analysis	Assessment
CO-5	Network Forensics Incidents, Using Routers as Response Tools	Usage
CO-6	Forensic Investigation Report and Forensic Tools	Usage

Course Contents:

Unit	Contents	Hours
1	Use a Web Search Engine, and search for companies specializing in computer forensics. Select three and write a two-to-three paper comparing what each company does.	**2**
2	Search the internet for articles on computer crime prosecutions. Find at least two. Write one or two pages summarizing the two articles and identify the key features of the decisions you find in your search.	**2**
3	Using a search engine, search for various computer forensics tools.	**2**
4	Preparing and processing of investigations. Try to examine and identify the evidence from the drives.	**2**
5	Extracting of files that have been deleted.	**2**
6	Illustrate any data acquisition method and validate it. Use an open-source	**2**

	data acquisition tool.	
7	You're investigating an internal policy violation when you find an e-mail about a serious assault for which a police report needs to be filed. What should you do? Write a two-page paper specifying who in your company you need to talk to first and what evidence must be turned over to police.	**2**
8	Create a file on a USB drive and calculate its hash value using FTK Imager. Change the file and calculate the hash value again to compare the files.	**2**
9	Compare two files created in Microsoft office to determine whether the files are different at the hexadecimal level. Keep a log of what you find.	**2**
10	Illustrate the analysis of forensics data.	**2**
11	Illustrate the validating of forensics data.	**2**
12	Locate and extract (JPEG) files with altered extensions.	**2**
13	Examine an E-mail message.	**2**
14	Investigate an E-mail message.	**2**
	Total Lab Hours	**28**

Suggested Text Book(s):

- "Computer Forensics and Investigations", Nelson, Phillips Enfinger, Steuart, Cengage Learning.

Suggested Reference Book(s):

- Brian Carrier, "File System Forensic Analysis" , Addison Wesley, 2005
- Dan Farmer & Wietse Venema ,"Forensic Discovery", Addison Wesley, 2005
- Eoghan Casey , ―Digital Evidence and Computer Crime ―, Edition 3, Academic Press, 2011
- Chris Pogue, Cory Altheide, Todd Haverkos ,Unix and Linux Forensic Analysis DVD ToolKit, Syngress Inc. , 2008
- Harlan Carvey ,Windows Forensic Analysis DVD Toolkit, Edition 2, Syngress Inc. , 2009
- Harlan Carvey ,Windows Registry Forensics: Advanced Digital Forensic Analysis of the Windows
- Registry , Syngress Inc, Feb 2011
- Eoghan Casey, Handbook of Digital Forensics and Investigation, Academic Press, 2009
- M Sonka, V Hlavac and R Boyle, Image Processing, Analysis and Machine Vision, PWS
- Pratt.W.K., Digital Image Processing, John Wiley and Sons, New York, 1978

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Project-1	10 Marks
4	Lab Assessment	45 Marks
5	Lab Attendance	5 Marks
	Total	100 marks

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	1.8
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	2
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	1.8
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	2.1
CO-5	2	2	2	2	3	1	1	1	2	2	1	2	1.8
CO-6	2	3	3	3	2	1	1	1	2	3	2	2	2.1
Average	2	2.5	2.5	2.5	2.5	1	1	1	2	2.3	1.5	2	1.9

Foundation for Data Science and Visualization

COURSE CODE: XXXXXXXX
COURSE CREDITS: 2
CORE/ELECTIVE: ELECTIVE
L-T-P: 2-0-0

Pre-requisite: Basic knowledge of high school mathematics and reasonable programming experience.

Course Objectives:

- Asking the correct questions and analyzing the raw data.
- Modeling the data using various complex and efficient algorithms.
- Visualizing the data to get a better perspective.
- Understanding the data to make better decisions and find the final result.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	Understanding the basics of data science	Familiarity
CO-2	Using versatile and flexible languages (Python and R programming) for supporting data science	Usage
CO-3	Using data processing for collecting and manipulating the data into the usable and desired form	Usage
CO-4	Using data visualization to easily access the huge amount of data in visuals	Usage
CO-5	Using statistics to collect and analyze the numerical data in a large amount and finding meaningful insights from i	Usage
CO-6	Understanding linear algebra to represent, model, synthesize and summarize the complex data	Usage

Course Contents:

Unit	Contents	Lectures Required
1	**Data Science an Introduction:** Computer Science, Data Science, and Real Science, What is Data Science? Need for Data Science, Data Science Components, Tools for Data Science, Data Science Lifecycle, Applications of Data Science	2

2	**Python and R Programming for Data Science for Data Science:** Introduction to Python Programming (Python Basics, Python Data Structures**,** Python Programming Fundamentals**,** Working with Data in Python**,** Working with NumPy, Pandas, SciPy, and Matplotlib). Introduction to R Programming (R basics, Data structures in R, R Programming fundamentals, Working with Data in R, Stings, and Dates in R, Discover R's packages to do graphics)	**5**
3	**Data Processing:** Data Operations**,** Data cleansing**,** Processing CSV Data**,** Processing JSON Data**,** Processing XLS Data**,** Relational databases**,** NoSQL Databases**,** Date and Time**,** Data Wrangling**,** Data Aggregation**,** Reading HTML Pages**,** Processing Unstructured Data**,** Word tokenization**,** Stemming and Lemmatization	**5**
4	**Statistical Data Analysis:** Measuring Central Tendency**,** Measuring Variance**,** Normal Distribution**,** Binomial Distribution**,** Poisson Distribution**,** Bernoulli Distribution**,** P-Value**,** Correlation**,** Chi-square Test**,** Linear Regression	**5**
5	**Linear Algebra:** Visualizing Matrix Operations **(**Matrix Addition, Matrix Multiplication, Applications of Matrix Multiplication**,** Identity Matrices and Inversion**,** Matrix Inversion and Linear Systems, Matrix Rank) Factoring Matrices **(**Why Factor Feature Matrices, LU Decomposition, and Determinants), Eigenvalues and Eigenvectors **(**Properties of Eigenvalues, Computing Eigenvalues), Eigenvalue Decomposition (Singular Value Decomposition, Principal Components Analysis)	**5**
6	**Data Visualization:** Chart Properties**,** Chart Styling**,** Box Plots**,** Heat Maps**,** Scatter Plots**,** Bubble Charts**,** 3D Charts**,** Time Series**,** Geographical Data**,** Graph Data	**6**
	Total Lecture Hours	**28**

Suggested Text Book(s):

- Data Science from Scratch by Joel Grus
- Data Science for Dummies by Lillian Pierson and Jake Porway
- An Introduction to Statistical Learning by Gareth James, Daniela Witten, et al.

Reference Book(s):

- An Introduction to Probability and Statistics by V.K. Rohatgi & A.K. Md. E. Saleh, Wiley, (2008), 3rd ed.
- Introduction to Probability Theory and Statistical Inference by H.J. Larson, John Wiley & Sons, (2005) 3rd ed.

Other useful resources (s):

- https://nptel.ac.in/courses/110/106/110106064/
- https://onlinecourses.nptel.ac.in/noc18_cs28/preview

Evaluation Scheme:

S No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Foundation for Data Science and Visualization)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	3	2	1	1	1	3	2	2	1	1.8
CO-2	3	3	3	3	3	1	1	2	2	2	1	1	2.1
CO-3	2	2	2	2	1	1	2	2	2	2	1	2	1.8
CO-4	3	3	3	3	2	1	1	3	2	3	3	2	2.4
CO-5	3	2	3	3	1	1	2	1	1	3	2	1	1.9
CO-6	2	2	1	2	2	2	3	2	1	2	3	1	1.9
Average	2.5	2.3	2.3	2.7	1.8	1.2	1.7	1.8	1.8	2.3	2	1.3	2.0

Data Science and Visualization Lab

COURSE CODE: XXX
COURSE CREDITS: 1
CORE/ELECTIVE: ELECTIVE
L-T-P: 0-0-2
Pre-requisite: Python/ R Programming and Machine Learning
Course Objectives:

- Asking the correct questions and analyzing the raw data.
- Modeling the data using various complex and efficient algorithms.
- Visualizing the data to get a better perspective.
- Understanding the data to make better decisions and find the final result.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	Understanding the basics of data science	Familiarity
CO-2	Using versatile and flexible languages (Python and R programming) for supporting data science	Usage
CO-3	Using data processing for collecting and manipulating the data into a usable and desired form	Usage
CO-4	Using statistics to collect and analyze the numerical data in a large amount and finding meaningful insights from i	Usage
CO-5	Understanding linear algebra to represent, model, synthesize and summarize the complex data	Usage
CO-6	Using data visualization to easily access the huge amount of data in visuals	Usage

List of Experiments

S No	Description	Hours
1	• Write a Python/R program to create a vector of a specified type and length. Create a vector of numeric, complex, logical, and character types of length 6. • Write a Python/R program to add two vectors of integer type and length 3. • Write a Python/R program to create a list containing a vector, a matrix, and a list and remove the second element • Write a Python/R program to create a list containing a vector, a matrix, and a list and update the last element.	**2**
2	Write Python/R programs to solve the following tasks in both of them. • Read numbers from a file, and print them out in sorted order. • Read a text file, and count the total number of words. • Read a text file, and count the total number of distinct words. • Read a file of numbers, and plot a frequency histogram of them	**2**
3	**Statistical Data Analysis**	**2**

Write a program to solve linear regression for a given data set.

$Y = ax + b$

where

$a = (n\Sigma xy - \Sigma x\Sigma y) / n\Sigma x^2 - \Sigma(x)^2$

$b = (\Sigma y - a\Sigma x)/n$

Here

Y: response variable

X: predicator variable

a, b: regression coefficients

Read data set

X	Y
-2	-1
1	1
3	2

4

Statistical Data Analysis

Solve the linear regression for a given data set, and also predict sales in the year 2012.

Year	Sales
2005	12
2006	19
2007	29
2008	37
2009	45

2

5

Statistical Data Analysis

Compute Logistic Regression for Organization dataset.

Response Variables

Y = Compensation in rupees

Prediction Variables

X_1 = Experience in years

X_2 = Education in years (after 10th standard)

X_3 = Number of Employees Supervised

X_4 = Number of Projects Handled

S No	Compensation	Experience	Education	Number supervised	Projects
1	1500	2	5	4	10
2	1650	3	6	5	10
3	1750	3	3	5	12
4	1400	2	3	3	9
5	2000	4	4	6	15
6	2200	5	6	6	14
7	2100	1	5	4	12
8	2750	5	8	7	15
9	2900	8	9	8	25
10	1100	3	3	2	7
11	1000	4	2	1	5
12	1350	6	4	4	12
13	1550	4	6	4	11

2

	Here you will get an error as y- value must be $0 < 1$. So modify Y values.	
6	**Statistical Data Analysis** • In an entrance examination, there are twenty multiple-choice questions. Each question has four options, and only one of them is correct. Find the probability of having seven or less than seven correct answers if a student attempts to answer every question at random. • Let us assume that the test scores an entrance exam fit a normal distribution where the mean test score is 67, and the standard deviation is 13.7. Calculate the percentage of students scoring 80 or more in the exam?	**2**
Mid-Semester Lab Examination		**2**
7	**Linear Algebra** Compare the speed of a library function for matrix multiplication to your implementation of the nested loops algorithm. • How much faster is the library on products of random $n \times n$ matrices, as a function of n as n gets large? • What about the product of an $n \times m$ and $m \times n$ matrix, where $n \times m$? • By how much do you improve the performance of your implementation to calculate $C = A \times B$ by first transposing **B** internally, so all dot products are computed along rows of the matrices to improve cache performance?	**2**
8	**Linear Algebra** Implement Gaussian elimination for solving systems of equations, $C \times X = Y$. Compare your implementation against a popular library routine for: • Speed: How does the run time compare, for both dense and sparse coefficient matrices? • Accuracy: What is the size of the numerical residuals $CX - Y$, particularly as the condition number of the matrix increases. • Stability: Does your program crash on a singular matrix? What about almost singular matrices, created by adding a little random noise to a singular matrix?	**2**
9	**Data Visualization** Construct a revealing visualization of some aspect of your favorite data set, using: • A well-designed table. • A dot and/or line plot. • A scatter plot. • A heatmap. • A bar plot or pie chart. • A histogram. • A data map.	**2**
10	**Data Visualization** Create ten different versions of line charts for a particular set of (x, y) points. Which ones are best and which ones worst? Explain why.	**2**
11	**Data Visualization**	**2**

	Construct scatter plots for sets of 10, 100, 1000, and 10,000 points. Experiment with the point size to find the most revealing value for each data set.	
12	**Data Visualization** Experiment with different color scales to construct scatter plots for a particular set of (*x*, *y*, *z*) points, where color is used to represent the z dimension. Which color schemes work best? Which are the worst? Explain why.	**2**
End-Semester Lab Examination		**2**
	Total Lab hours	**28**

Suggested Text Books:

- Python Data Science Hand Book Jake VanderPlas
- Mastering Python for Data Science - by Samir Madhavan.
- R Programming for Data Science by Roger D. Peng

Reference Books:

- Python Data Science: Hands-on Learning for Beginners Kindle Edition by Travis Booth (Author)
- Data Science with R: A Step By Step Guide with Visual Illustrations & Examples by Andrew Oleksy
- R for Data Science: Import, Tidy, Transform, Visualize, and Model Data by Hadley Wickham (Author), Garrett Grolemund

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Project-1	10 Marks
4	Lab Assessment	45 Marks
5	Lab Attendance	5 Marks
	Total	100 marks

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Data Science and Visualization Lab)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	3	2	1	1	1	3	2	2	1	1.8
CO-2	3	3	3	3	3	1	1	2	2	2	1	1	2.1
CO-3	2	2	2	2	1	1	2	2	2	2	1	2	1.8
CO-4	3	3	3	3	2	1	1	3	2	3	3	2	2.4
CO-5	3	2	3	3	1	1	2	1	1	3	2	1	1.9
CO-6	2	2	1	2	2	2	3	2	1	2	3	1	1.9
Average	2.5	2.3	2.3	2.7	1.8	1.2	1.7	1.8	1.8	2.3	2	1.3	2.0

Computational Data Analysis

COURSE CODE: XXXXXXXX
COURSE CREDITS: 2
CORE/ELECTIVE: ELECTIVE
L-T-P: 2-0-0
Pre-requisite: Basics of probability and statistics
Course Objectives:

1. To provide students with the foundational knowledge of topics such as probability and statistics and algorithms to solve data analysis problems arising in practical applications,
2. To enable students to effectively apply computational methods to solve exemplar data analysis problems arising in relevant applications.
3. Have a good understanding of the fundamental issues and challenges of machine learning.
4. Have an understanding of the strengths and weaknesses of many popular machine learning approaches.
5. Be able to design and implement various machine learning algorithms in a range of real-world applications.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	To learn the basic concepts and terminology in statistics used in machine learning	Familiarity
CO-2	To understand the concepts associated with the classification and experimental evaluation of classification algorithms	Familiarity
CO-3	To learn about clustering and unsupervised learning	Assessment
CO-4	To learn about various techniques for selecting relevant features selection.	Assessment
CO-5	To learn about various techniques for enhancing the performance of basic machine learning algorithms.	Usage

Course Contents:

Unit	Contents	Lectures Required
1	Supervised Learning, Discriminative Algorithms: Supervised Learning Concept, Linear Regression, Maximum Likelihood, Normal Equation, Gradient Descent, Stochastic Gradient, SVRG. Linear Classification, Logistic Regression.	**5**
2	Generative Algorithms: Multivariate Normal, Linear Discriminant Analysis, Naive Bayes,	**5**

	Laplacian Smoothing, Multiclass Classification, K-NN Multi-class Fisher Discriminant Analysis, Multinomial Regression Support Vector Machines and Kernel Methods: Intuition, Geometric Margins, Optimal Margin Classifier, Multiclass SVM	
3	Unsupervised Learning: EM Algorithm, DBSCAN, k-means, Hierarchical clustering	**4**
4	Regularization, Model Selection, and Optimization: Cross-Validation, Bayesian Optimization Bayesian Regression, Bayesian Logistic Regression Forward and Backward Regression, Lasso, elastic-net. Proximal Gradient, Prox-SVRG. Coordinate Proximal Gradient, Pathwise Coordinate Descent	**5**
5	Feature Selection: Information Gain, Correlation Coefficient, Chi-square test, PCA	**4**
6	Ensemble Learning: Bagging, Boosting, Stacking, Entropy, Building Tree, Bagging features, Bagging Samples, Random Forest, Adaboost, Gradient Tree Boosting	**5**
	Total Lecture Hours	**28**

Suggested Text Book(s):

- Tom Mitchell, "Machine Learning", McGraw Hill, 1997, ISBN 0070428077
- Introduction to Machine Learning Edition 2, by Ethem Alpaydin.
- T. Hastie, R. Tibshirani, & J. H. Friedman, "The Elements of Statistical Learning: Data Mining, Inference, and Prediction", Springer Verlag, 2001.

Suggested Reference Book(s):

- The Elements of Statistical Learning, 2nd Edition, Hastie, Tibshirani and Friedman.
- Foundations of Machine Learning, Mohri, Rostamizadeh and Talwalker
- Richard o. Duda, Peter E. Hart, and David G. Stork, "Pattern Classification", John Wiley Asia, 2006

Other useful resources (s):

- Link to NPTEL course contents: https://nptel.ac.in/courses/106106139/
- https://nptel.ac.in/courses/110106064/

Evaluation Scheme:

S No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Computational Data Analysis)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	1.8
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	2
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	1.8
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	2.1
CO-5	1	2	2	1	3	2	1	1	1	1	1	1	1.4
Average	1.8	2.4	2.4	2.2	2.6	1.2	1	1	1.8	2	1.4	1.8	1.8

Computational Data Analysis Lab

COURSE CODE: XXXXXXXX
COURSE CREDITS: 1
CORE/ELECTIVE: ELECTIVE
L-T-P: 0-0-2
Pre-requisite: Python Programming Language

Course Objectives:

1. To develop students' skills in software development techniques using one or more high-level programming languages relevant to data analytics.
2. To enable students to effectively apply computational methods to solve exemplar data analysis problems arising in relevant applications.
3. To learn the implementation of classification techniques for any dataset.
4. To conduct experiments for clustering techniques for any dataset.
5. To discuss different classification and clustering algorithms based on the analysis of results obtained from the experimental evaluation.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO1	To learn and implement the basic concepts and terminology in statistics used in machine learning	Usage
CO2	To implement classification and clustering algorithms in python	Usage
CO3	To implement feature selection methods in Python	Usage
CO4	To compare different algorithms based on some common factors	Assessment

List of Experiments

S No	Description	Hours
1	Visualize data using any plotting framework How to upload a dataset How to retrieve rows and data in the dataset How to delete a certain column in the dataset How to display minimum, maximum value of a particular feature How to display certain rows of a dataset	**2**
2	Visualize data using any plotting framework How to display certain rows of a dataset How to insert a new row at a particular index Visualization of the dataset (scatterplot, histogram) To find the sum of null values in each column Extracting certain columns	**2**
3	Implement SVM using different kernel methods like Gaussian Radial Basis Function (RBF), Laplace RBF kernel, ANOVA Radial Basis kernel,	**2**

	Polynomial Kernel.	
4	Implement Naïve Bayes using Bernoulli model and Multinomial model (Laplace smoothing and Log-Transformation).	**2**
5	Implement K-NN and DT	**2**
6	Implement Linear regression and Logistic regression	**2**
7	Implement the following clustering techniques: K-means, *Hierarchical,*	**2**
8	Implement the following clustering techniques: *DBSCAN,* EM Algorithm	**2**
9	Implement various feature selection methods Information Gain Correlation Coefficient	**2**
10	Implement various feature selection methods Chi-square test PCA	**2**
11	Implement the following ensemble techniques: XGBoost, AdaBoost	**2**
12	Implement the following ensemble techniques: Gradient Boosting, Bagging	**4**
	Total Lab hours	**28**

Suggested/Resources:

- Tom Mitchell, "Machine Learning", McGraw Hill, 1997, ISBN 0070428077
- Sebastian Raschka, "Python Machine Learning", Packt Publishing Ltd.
- Andreas C. Müller, Sarah Guido, "Introduction to Machine Learning with Python", O'Reilly Media, Inc.
- Sunila Gollapudi, "Practical Machine Learning", Packt Publishing Ltd
- Wes McKinney, "Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython", O'Reilly Media, Inc.
- Willi Richert, "Building Machine Learning Systems with Python", Packt Publishing Ltd.

Link to topics related to course:

- https://www.python-course.eu/machine_learning.php
- https://www.analyticsvidhya.com/blog/2018/05/24-ultimate-data-science-projects-to-boost-your knowledge-and-skills/
- https://www.datacamp.com/

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Attendance	10 Marks
4	Project	20 Marks
5	Lab Assessment	30 Marks
	Total	**100 marks**

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	Average
CO-1	3	2	2	2	3	1	1	1	1	1	2	2	1.8
CO-2	3	3	3	3	3	2	1	2	2	1	2	3	2.3
CO-3	3	3	2	3	3	2	1	2	2	1	2	3	2.3
CO-4	3	3	3	3	3	2	1	2	2	1	2	3	2.3
Average	3	2.8	2.5	2.8	3	1.8	1	1.8	1.8	1	2	2.8	2.2

Big Data and Hadoop

COURSE CODE: XXXXXXXX
COURSE CREDITS: 2
CORE/ELECTIVE: ELECTIVE
L-T-P: 2-0-0
Pre-requisite: None
Course Objectives:

1. Understand the fundamentals of Concepts in BigData and Hadoop etc
2. Understand the fundamentals of Hadoop etc.
3. Be able to use the HDFS file system, debug and run simple Java programs for HDFS.
4. Be aware of the important topics and principles of software development and write better &more maintainable code
5. Be able to program using advanced Java topics like JDBC, Servlets, and JSP.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	What is big data: introduction to the data lake, why do companies care for big data, why do we out of big data, social media	Familiarity
CO-2	History of Hadoop, the importance of HDFS: Hadoop timeline, why Hadoop, Hadoop 1.x architecture, core components, and job process	Assessment
CO-3	Different phases in Map Reduce: input-output formats in each phase, modeling real-world applications in map-reduce, understanding map-reduce program execution, problems in map-reduce	Assessment
CO-4	Apache Hive, Apache PIG: introduction to Hive meta store, SQL vs Hive, Hive query language, managed and external tables, querying data, introduction to PIG, map-reduce vs PIG, PIG in local mode, PIG in the map-reduce mode	Usage
CO-5	SQOOP: Introduction to SQOOP framework, SQOOP flavors of import, SQOOP flavors of export, SQOOP CLI options	Usage
CO-6	FLUME: Introduction to messaging service, applications of a messaging service, FLUME architecture framework, working of a FLUME agent, understanding FLUME configurations, Hadoop ecosystem labs, importing data from MYSQL and querying it using HIVE, configuring FLUME agent to listen to local log files	Assessment

Course Contents:

Unit	Contents	Lectures Required
1	What is big data: introduction to the data lake, why do companies care for big data, why do we out of big data, social media	4
2	History of Hadoop, the importance of HDFS: Hadoop timeline, why Hadoop, Hadoop 1.x architecture, core components, and job process	4
3	Different phases in Map Reduce: input-output formats in each phase, modeling real-world applications in map-reduce, understanding map-reduce program execution, problems in map-reduce	5
4	Apache Hive, Apache PIG: introduction to Hive meta store, SQL vs Hive, Hive query language, managed and external tables, querying data, introduction to PIG, map-reduce vs PIG, PIG in local mode, PIG in a map-reduce mode	4
5	SQOOP: Introduction to SQOOP framework, SQOOP flavors of import, SQOOP flavors of export, SQOOP CLI options	6
6	FLUME: Introduction to messaging service, applications of a messaging service, FLUME architecture framework, working of a FLUME agent, understanding FLUME configurations, Hadoop ecosystem labs, importing data from MYSQL and querying it using HIVE, configuring FLUME agent to listen to local log files	5
	Total Lecture Hours	**28**

Suggested Text Book(s):

- Big Data and Hadoop, V.K. Jain (https://books.google.co.in/books?id=i6NODQAAQBAJ&printsec=frontcover&redir_esc=y#v=onepage&q&f=false).
- Big Data and Hadoop, MAYANK BHUSHAN**.**

Other useful resources (s):

- https://www.youtube.com/watch?v=1vbXmCrkT3Y

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered up to T-1
2	T-2	25	1.5 Hours	Syllabus covered up to T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Big Data and Hadoop)	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**Average**
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	**1.8**
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	**2**
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	**1.8**
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	**2.1**
CO-5	2	3	1	1	2	3	2	1	2	3	3	2	**2.1**
CO-6	2	3	3	2	1	3	2	2	3	3	2	2	**2.3**
Average	**2**	**2.7**	**2.3**	**2.2**	**2.2**	**1.7**	**1.3**	**1.2**	**2.2**	**2.5**	**1.8**	**2**	**2**

Big Data and Hadoop Lab

COURSE CODE: XXXXXXXX
COURSE CREDITS: 1
CORE/ELECTIVE: ELECTIVE
L-T-P: 0-0-2

Pre-requisites: An understanding in practicalities of big data and Hadoop to any programming language (Preferably, C)

Course Objective

The lab course provides a complete description of the inner working of big data and Hadoop. The main focus is on the design of big data techniques. The course also aims to convey the language specifications, use of file management tasks, and map-reduce behind the design of algorithms. It builds an understanding of various techniques like map-reduce, pig Latin scripts, etc.

Course Outcomes (COs):

S No	Course outcomes	Level of Attainment
CO-1	Perform setting up and Installing Hadoop in various operating modes	Familiarity
CO-2	Implement file management tasks in Hadoop	Familiarity
CO-3	Running a Map-Reduce Paradigm	Computational skills
CO-4	Run Pig then write Pig Latin scripts	Technical skills

List of Experiments

S No	Topic	Hours
1	Implement the following data structures in Java: Linked list, stacks, queues, Set and Map	**2**
2	Perform setting up and Installing Hadoop in its three operating modes: Standalone, Pseudo distributed, Fully distributed Use web-based tools to monitor your Hadoop setup.	**4**
3	Implement the following file management tasks in Hadoop: • Adding files and directories • Retrieving files • Deleting files Hint: A typical Hadoop workflow creates data files (such as log files) elsewhere and copies them into HDFS using one of the above command-line utilities.	**4**

4	Run a basic Word Count Map Reduce program to understand Map Reduce Paradigm	**4**
5	Write a Map Reduce program that mines weather data. Weather sensors collecting data every hour at many locations across the globe gather a large volume of log data, which is a good candidate for analysis with Map Reduce since it is semi-structured and record-oriented	**4**
6	Implement Matrix Multiplication with Hadoop Map Reduce	**2**
7	Install and Run Pig then write Pig Latin scripts to sort, group, join, project, and filter your data	**4**
8	Install and Run Hive then use Hive to create, alter, and drop databases, tables, views, functions, and indexes	**4**
	Total Lab Hours	**28**

Evaluation Scheme

S No	Exam	Coverage/Scope of Examination	Marks
1	Mid Term Test	Viva and Written Exam	20
2	End Term Test	Viva and Written Exam	20
3	Lab Records		15
4	Teacher Assessment	(Quality and quantity of experiment performed, learning laboratory skills)	30
5	Attendance and discipline in lab		15
	Total		**100**

Reference Books:

- Big Data and Hadoop, V.K. Jain
- Big Data and Hadoop, MAYANK BHUSHAN

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	2	2	2	1	3	3	2	1	3	2	1	2.1
CO-2	3	3	2	2	1	3	3	1	3	3	3	1	2.3
CO-3	3	3	2	2	2	2	2	1	2	3	3	2	2.3
CO-4	3	3	3	2	2	2	3	2	2	1	2	2	2.3
CO-5	3	3	2	1	1	3	3	1	3	3	3	1	2.3
Average	3	2.8	2.2	1.8	1.4	2.6	2.8	1.4	2.2	2.6	2.6	1.4	2.2

Computability, Complexity, and Algorithms

COURSE NAME: Computability, Complexity and Algorithms
COURSE CODE: XXXXXXXX
COURSE CREDITS: 3
CORE/ELECTIVE: ELECTIVE
L-T-P: 3-0-0
Pre-requisite: None

Course Objectives:

1. Learn to analyze algorithms for Time and Space Complexity
2. Learn asymptotic notations for performance analysis of algorithms.
3. Learn various computational and complexity of randomized algorithms.
4. Apply important algorithmic design paradigms and methods of analysis.
5. Synthesize efficient mathematical induction and asymptotic notations.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	Introduction of algorithms	Familiarity
CO-2	Demonstrate familiarity with major topics of algorithm analysis.	Assessment
CO-3	Introduction of computability theory.	Assessment
CO-4	Analysis of time complexity of randomized algorithms.	Usage
CO-5	An introduction of probability and randomized algorithms	Usage
CO-6	A brief description of probability, mathematical induction, and asymptotic notations	Assessment

Course Contents:

Unit	Contents	Lectures Required
1	**Introduction to algorithm analysis:** Basic introduction of algorithms, divide and conquer paradigm, Asymptotic notations, Probabilistic and randomized algorithms.	**7**
2	**Advanced algorithm I:** Dynamic programming, Greedy algorithms, and amortized analysis.	**7**
3	**Advanced topics in algorithms II:** Graph algorithm, flow in networks, bipartite matching's.	**6**
4	**Computability Theory:** Turing machines, decidability, mapping reducibility	**6**
5	**Complexity Theory:** Introduction to time complexity, NP and NP-completeness, Approximation algorithms, and derandomization.	**7**
6	**Probabilistic and Randomized Algorithms:** Probabilistic algorithms; Randomizing deterministic algorithms, Monte Carlo and	**6**

	Las Vegas algorithms; Probabilistic numeric Algorithms.	
7	**Supplementary material: Mathematical induction, asymptotic notations, and probability**	**3**
	Total Lecture Hours	**42**

Suggested Text Book(s):

- V. J. Rayward-Smith, *A first course in computability,* McGraw Hill, 1995? An introductory paperback that covers Parts I and III of the course, and some of Part II. More detailed than this course.

- D. Harel, *The Science of Computing,* Addison-Wesley, 1989. A good book for background and motivation, with fair coverage of this course and a great deal more. Some may find the style diffuse. Less detailed than this course

Suggested Reference Book(s):

- Robert Sedgewick, *Algorithms,* Addison-Wesley, 2nd ed., 1988. A practical guide to many useful algorithms and their implementation. A reference for Part II of the course.
- J. Bell, M. Machover, *A course in mathematical logic,* North-Holland, 1977. A good mathematical text, for those who wish to read beyond the course.
- G. Boolos, R. Jeffrey, *Computability and Logic,* Cambridge University Press, 1974

Other useful resources (s):

- youtube.com/playlist?list=PLLkyyG3XCR1mCH_XAWGdm9u4h_VTIRYC-

Evaluation Scheme:

S No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered up to T-1
2	T-2	25	1.5 Hours	Syllabus covered up to T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Computability, Complexity, and Algorithms)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	1.8
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	2
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	1.8
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	2.1
CO-5	2	3	1	1	2	3	2	1	2	3	3	2	2.1
CO-6	2	3	3	2	1	3	2	2	3	3	2	2	2.3
Average	2	2.7	2.3	2.2	2.2	1.7	1.3	1.2	2.2	2.5	1.8	2	2

Course Outcomes (COs) contribution to PSOs

Attainment of PSOs through COs					
Sr. No.	PSO-1	PSO-2	PSO-3	PSO-4	Average
CO-1	3	2	2	1	2
CO-2	3	3	2	2	2.5
CO-3	3	2	3	2	2.5
CO-4	3	3	2	3	2.8
CO-5	3	2	2	1	2
CO-6	3	2	1	2	2
Average Score	3	2.3	2	1.8	

Computability, Complexity and Algorithms Lab

Course Code: XXXXXXX
Course Title: Computability, Complexity and Algorithms Lab
Course Credits: 01
CORE/ELECTIVE: ELECTIVE
Semester: VIIIth Semester
L-T-P: 0-0-2

Pre-requisites: An understanding in practicalities of Computability, Complexity, and Algorithms to any programming language (Preferably, C)

Course Objective
The lab course provides a complete description of the inner working of complexity and algorithms. The main focus is on the design of algorithms and computational techniques. The course also aims to convey the language specifications, use of regular expressions, and computations behind the design of algorithms.
Course Outcome (CO)

S No	Course outcomes	Level of Attainment
CO-1	Construction of dynamic and greedy algorithms	Familiarity
CO-2	Analyzing the *t*ime complexity of graph, dynamic and greedy methods	Familiarity
CO-3	Construction of minimization of automata	Computational skills
CO-4	Building various probabilistic techniques	Technical skills

List of Practical

S. No	Topic	Hours
1	Write a program to read and translate integers into numbers. e.g. 1=ONE, 12 = ONE TWO and 856 = EIGHT FIVE SIX, Generate an error if the number of digits is more than 3	**2**
2	Write a program to convert infix notation to postfix notation.	**2**
3	Implement a DFA which simulates the regular expression a + (aa)*b.	**4**
4	Write a program to implement minimization of finite automata	
5	Implementation of greedy algorithms	**4**
6	Implementation of dynamic programming algorithms	
7	Program for computation of computability and complexity theory.	**4**
8	Write a program to check advanced algorithms like dynamic programming, greedy algorithm.	**4**
9	Implementation of an approximation algorithm	**4**
10	Implementation of a randomized algorithm	**4**
	Total Lab Hours	**28**

Evaluation Scheme

S No	Exam	Coverage/Scope of Examination	Marks
1	Mid Term Test	Viva and Written Exam	20
2	End Term Test	Viva and Written Exam	20
3	Lab Records		15
4	Teacher Assessment	(Quality and quantity of experiment performed, learning laboratory skills)	30
5	Attendance and discipline in lab		15
6	Total		100

Reference Booka

- V. J. Rayward-Smith, *A first course in computability,* McGraw Hill, 1995? An introductory paperback that covers Parts I and III of the course, and some of Part II. More detailed than this course.

- D. Harel, *The Science of Computing,* Addison-Wesley, 1989. A good book for background and motivation, with fair coverage of this course and a great deal more. Some may find the style diffuse. Less detailed than this course

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	2	2	1	2	3	3	2	1	3	2	1	2.1
CO-2	3	3	2	1	1	3	3	1	3	3	3	1	2.3
CO-3	3	3	1	1	2	2	2	1	2	3	3	2	2.1
CO-4	3	3	2	2	2	2	3	2	2	1	2	2	2.2
CO-5	3	3	2	1	1	3	3	1	3	3	3	1	2.3
Average	3	2.8	1.8	1.2	1.6	2.6	2.8	1.4	2.2	2.6	2.6	1.4	2.2

Course Outcomes (COs) contribution to PSOs

Attainment of PSOs through COs					
Sr. No.	PSO-1	PSO-2	PSO-3	PSO-4	Average
CO-1	3	2	2	1	2
CO-2	3	3	2	2	2.5
CO-3	3	2	3	2	2.5
CO-4	3	3	2	3	2.8
CO-5	3	2	2	1	2
CO-6	3	2	1	2	2
Average Score	3	2.3	2	1.8	

Computer and Robot Vision

Course Name: Computer and Robot Vision
Course Code: XXXXX
Course Credits: 3
CORE/ELECTIVE: ELECTIVE
L-T-P: 3-0-0
Pre-requisite: Image Processing and Robotics

Course Objectives:

1. To learn fundamental image processing techniques required for computer vision.
2. To learn shape analysis and boundary tracking.
3. To learn and apply chain codes and other region descriptors.
4. To learn and apply the Hough Transform for line, circle, and ellipse detections.
5. To learn and apply 3D vision techniques, implement motion-related techniques, and Develop applications using computer vision techniques.

Course outcomes:

S No	Course outcomes	Level of Attainment
CO-1	Implement fundamental image processing techniques required for computer vision	Familiarity
CO-2	Perform shape analysis and implement boundary tracking techniques	Usage
CO-3	Apply chain codes and other region descriptors.	Usage
CO-4	Apply Hough Transform for line, circle, and ellipse detections	Usage
CO-5	Apply 3D vision techniques, implement motion-related techniques, and Develop applications using computer vision techniques	Usage

Detailed Course Contents:

Unit	Contents	Lectures required
1	**CAMERAS:** Pinhole Cameras, **Radiometry – Measuring Light:** Light in Space, Light Surfaces, Important Special Cases, **Sources, Shadows, And Shading:** Qualitative Radiometry, Sources, and Their Effects, Local Shading Models, Application: Photometric Stereo, Interreflections: Global Shading Models, **Color:** The Physics of Color, Human Color Perception, Representing Color, A Model for Image Color, Surface Color from Image Color.	**8**
2	**Linear Filters:** Linear Filters and Convolution, Shift Invariant Linear Systems, Spatial Frequency, and Fourier Transforms, Sampling, and Aliasing, Filters as Templates, **Edge Detection:** Noise, Estimating Derivatives, Detecting Edges, **Texture:** Representing Texture, Analysis (and Synthesis) Using Oriented	**8**

	Pyramids, Application: Synthesis by Sampling Local Models, Shape from Texture.	
3	**The Geometry of Multiple Views:** Two Views, **Stereopsis:** Reconstruction, Human Stereposis, Binocular Fusion, Using More Cameras, **Segmentation by Clustering:** What Is Segmentation?, Human Vision: Grouping and Gestalt, Applications: Shot Boundary Detection and Background Subtraction, Image Segmentation by Clustering Pixels, Segmentation by Graph-Theoretic Clustering,	**8**
4	**Segmentation by Fitting a Model:** The Hough Transform, Fitting Lines, Fitting Curves, Fitting as a Probabilistic Inference Problem, Robustness, **Segmentation and Fitting Using Probabilistic Methods:** Missing Data Problems, Fitting, and Segmentation, The EM Algorithm in Practice, **Tracking With Linear Dynamic Models:** Tracking as an Abstract Inference Problem, Linear Dynamic Models, Kalman Filtering, Data Association, Applications, and Examples.	**8**
5	**Geometric Camera Models:** Elements of Analytical Euclidean Geometry, Camera Parameters and the Perspective Projection, Affine Cameras and Affine Projection Equations, **Geometric Camera Calibration:** Least-Squares Parameter Estimation, A Linear Approach to Camera Calibration, Taking Radial Distortion into Account, Analytical Photogrammetry, An Application: Mobile Robot Localization, **Model-Based Vision:** Initial Assumptions, Obtaining Hypotheses by Pose Consistency, Obtaining Hypotheses by pose Clustering, Obtaining Hypotheses Using Invariants, Verification, Application: Registration In Medical Imaging Systems, Curved Surfaces, and Alignment.	**10**
	Total Lecture Hours	**42**

Evaluation Scheme:

S No	Exam	Marks	Duration	Coverage/Scope of Examination
1	Test -1	15	1 hr.	Syllabus covered upto T- 1
2	Test -2	25	1 hr 30 min.	Syllabus covered upto T- 2
3	Test - 3	35	2 hours	Full Syllabus
4	Regularity, Assignments, Quizzes.	25	Entire Semester	Regularity- 4 Assignments - 9 Quizzes - 12

Text Books:

- David A. Forsyth and Jean Ponce: Computer Vision – A Modern Approach, PHI Learning (Indian Edition), 2009.

Reference Books:

- E. R. Davies: Computer and Machine Vision – Theory, Algorithms and Practicalities, Elsevier (Academic Press), 4th edition, 2013.

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

COs	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	3	3	2	3	3	2	3	2	3	3	2.8
CO-2	3	3	3	3	2	3	3	2	3	2	3	3	2.8
CO-3	3	3	3	3	2	3	3	2	3	2	3	3	2.8
CO-4	3	3	3	3	2	3	3	2	3	2	3	3	2.8
CO-5	3	3	3	3	2	3	3	2	3	2	3	3	2.8
CO-6	3	2	2	3	3	3	3	2	3	2	3	3	2.7
Average	3	2.8	2.8	3	2.2	3	3	2	3	2	3	3	2.7

Computer and Robot Vision Lab

Course Name: Computer and Robot Vision Lab
Course Code: xxx
Course Credits: 01
CORE/ELECTIVE: ELECTIVE
L-T-P: 0-0-2
Pre-requisites: Image Processing and Artificial Intelligence

Objective: The main target of computer vision is the 3-D world. Most computer vision algorithms require some form of image processing. Robot vision is to program a **robot** to "see" through a camera either mounted on the **robot**, or in a static position, takes pictures of each workpiece that the **robot** will interact with. This course integrates the two disciplines to achieve a significant purpose.

Course Outcomes (COs)

S No	Course outcomes	Level of Attainment
CO 1	To study cameras, radiometry, sources, and properties.	Familiarity
CO 2	To understand and implement linear filters, edge detection, and texture.	Usage
CO 3	To understand and implement the Geometry of Multiple Views, Stereopsis, and Segmentation by Clustering.	Usage
CO 4	To understand and implement Segmentation by Fitting a Model, Segmentation and Fitting Using Probabilistic Methods, and Tracking With Linear Dynamic Models.	Usage
CO 5	To understand and implement Geometric Camera Models and Geometric Camera Calibration.	Usage

List of experiments

S No	Topic	Hours
1	Pinhole Cameras, Radiometry – Measuring Light, Sources, Shadows, And Shading, Color	6
2	Linear Filters, Edge detection, and Texture	6
3	The Geometry of Multiple Views, Stereopsis, and Segmentation by Clustering	6
4	Segmentation by Fitting a Model, Segmentation and Fitting Using Probabilistic Methods, and Tracking With Linear Dynamic Models	6
5	Geometric Camera Models and Geometric Camera Calibration	4
	Total Lab Hours	**28**

Evaluation Scheme:

S No	Exam	Coverage/Scope of Examination	Marks
1	Mid Term Test	Viva and Written Exam	20
2	End Term Test	Viva and Written Exam	20
3	Lab Records		15
4	Teacher Assessment	(Quality and quantity of experiment performed, learning laboratory skills)	30
5	Attendance and discipline in lab		15
6	Total		100

Text Books:

- David A. Forsyth and Jean Ponce: Computer Vision – A Modern Approach, PHI Learning (Indian Edition), 2009.

Reference Books:

- E. R. Davies: Computer and Machine Vision – Theory, Algorithms and Practicalities, Elsevier (Academic Press), 4th edition, 2013.

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

S No	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	3	2	2	3	1	1	2	1	1	3	2.1
CO-2	3	3	3	3	3	3	1	1	2	1	1	3	2.3
CO-3	3	3	3	3	3	3	1	1	2	1	1	3	2.3
CO-4	3	3	3	3	3	3	1	1	2	1	1	3	2.3
CO-5	3	3	3	3	3	3	1	1	2	1	1	3	2.3
CO-6	3	3	3	3	3	3	1	1	2	1	1	3	2.3
Average	3	3	3	2.8	2.8	3	1	1	2	1	1	3	2.2

Human-Computer Interaction

Course Name: Human-Computer Interaction
Course Code: XXXXX
Course Credits: 2-0-0
CORE/ELECTIVE: ELECTIVE
L-T-P: 3-0-0
Pre-requisite: Image Processing and Robotics

Course Objectives:

- Design, implement, and evaluate effective and usable graphical computer interfaces.
- Describe and apply core theories, models, and methodologies from the field of HCI.
- Describe and discuss current research in the field of HCI.
- Implement simple graphical user interfaces using the Java Swing toolkit.
- Describe special considerations in designing user interfaces for older adults.

Course Outcomes:

S No	Course outcomes	Level of Attainment
CO-1	To learn to explain why it is important to design interactive products that are usable, define key terms used in interaction design	Familiarity
CO-2	To learn to explain key theories used in the design of interactive products and to explain the importance of iteration, evaluation, and prototyping in interaction design	Familiarity
CO-3	To gather data in the context of developing a simple interactive product using suitable techniques	Technical Skills
CO-4	To produce a low-fidelity prototype for an interactive product based upon a simple list of interaction design principles and to evaluate an interactive product using suitable techniques	Technical Skills
CO-5	To communicate effectively to peers and specialists about requirements, design, and evaluation activities relating to interactive products	Key Skills
CO-6	To define a suitable program of user involvement that treats users ethically and fairly.	Key Skills

Course Contents:

:

Unit	Topic	Lectures required
1	Principles of HCI : History and Foundations of HCI, Research Frameworks in HCI, Modeling Social and Emotional Processes, Computer-Mediated Communication, Social and Embodied Interfaces I, II, Computer-Supported	4

	Collaborative Work	
2	Principles of HCI : Speech Interfaces, Games, Crowdsourcing, Information Visualization, Ubiquitous Computing, Assistive and Accessible Interfaces, Future of HCI	7
3	Human Subjects Research Methods: Introduction: Research methods in HCI, Introduction: What are elements of a research project in HCI?, Introduction: How to choose research designs?, Introduction: Methodological fit, Qualitative research: data collection, Qualitative research: data analysis	5
4	Quantitative research: Experimental design principles, Quantitative research: Step-by-step experimental design, Quantitative research: Measurement, Part I, Quantitative research: Measurement, Part II, Quantitative research: Measurement, Part III, Quantitative research: Scale construction, Quantitative research: Statistics, Part I, Quantitative research: Statistics, Part II, Quantitative research: Statistics, Part III	8
5	**Project:** Completing the required human-subjects research training program and an Institutional Review Board (IRB) application for the project, Gaining a theoretical and empirical understanding of the application domain, Applying exploratory and experimental research methods in HCI	2
6	Prototyping user interfaces, Designing exploratory and experimental studies, Gaining experience in recruiting participants, and conducting studies with human subjects, Creating generalizable knowledge on how computing can improve aspects of human life.	2
	Total Lecture Hours	28

Evaluation Scheme

S No	Exam	Marks	Duration	Coverage/Scope of Examination
1	Test -1	15	1 hr.	Syllabus covered up to T- 1
2	Test -2	25	1 hr 30 min.	Syllabus covered up to T- 2
3	Test - 3	35	2 hours	Full Syllabus
4	Regularity, Assignments, Quizzes.	25	Entire Semester	Regularity- 4 Assignments - 9 Quizzes - 12

Reference Books:

- Interaction the BCS Specialist Group on Interaction
- The Usability Professionals' Association (UPA) - founded in the US, with local chapters in the US and other countries
- Mikael Ericsson's listing of research labs and projects worldwide
- Ubiquity - ACM online magazine (general IT topics, but lots relevant to HCI)
- Alan's column and resources on HCI Education in SIGCHI Bulletin
- HCI International has a bi-monthly subscription newsletter partly about the conference,but also carrying general news, events, etc. back issues at their Press Room

- Videos in User-System Interaction - collated by Matthias Rauterberg
- The HCI Bibliography - free-access online bibliographic database on Human-Computer Interaction
- HCI Resource Network - event listings, links, jobs, and subscription-only sections, includes A-Z of HCI topics
- Hans de Graaff's HCI Index
- Craig Marion's Software Design Smorgasbord
- Gary Perlman's Resources in HCI columns from Interactions
- University of Michigan HCI resource links
- The Usability First web site has good collections of resources, particularly for web and accessibility
- Usability First glossary of usability terms
- CHI recently completed theses list
- ComputingCases.org a resource site for teaching ethical issues in computing
- SAP Usability Glossary

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Sr No	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Avg
CO-1	3	2	2	1	2	3	3	2	1	1	1	3	2
CO-2	3	3	3	2	1	1	1	3	2	1	1	3	2
CO-3	3	3	2	3	2	1	1	2	2	1	1	2	1.9
CO-4	3	3	3	3	2	1	1	3	2	1	1	2	2.1
CO-5	3	3	3	3	2	1	1	3	2	1	1	3	2.2
CO-6	3	3	3	3	2	1	1	3	2	1	1	3	2.2
Avg	3	2.8	2.7	2.5	1.8	1.3	1.3	2.7	1.8	1	1	2.7	2.1

Human-Computer Interaction Lab

Course Name: Human-Computer Interaction Lab
Course Code: XXXXX
Course Credits: 1
CORE/ELECTIVE: ELECTIVE
L-T-P: 0-0-2

Pre-requisite: Image Processing and Robotics

Course Objective:
This course provides an introduction to and overview of the field of human-computer interaction (HCI). HCI is an interdisciplinary field that integrates theories and methodologies from computer science, cognitive psychology, design, and many other areas. Course readings will span current theory and practice in interface specification, design and evaluation, as well as current and classic research papers in HCI. Students will work on both individual and team projects to design, implement and evaluate computer interfaces. The course is open to students from all disciplines, providing them with experience working in interdisciplinary design teams.
Lab course of two hours per week will supplement the theory. Implementation of basic and advanced algorithms will be done with C/C++. Basic knowledge of C/C++ programming is mandatory.
The course will involve four hours of contact including lectures, tutorials and lab classes. Students are strongly encouraged to participate actively in class discussions.

Course Outcomes (COs)

S No	Course outcomes	Level of Attainment
CO 1	To design interactive products that are usable, define key terms used in interaction design, explain key theories used in the design of interactive products.	Familiarity
CO 2	To explain the importance of iteration, evaluation, and prototyping in interaction design.	Usage
CO 3	To gather data in the context of developing a simple interactive product using suitable techniques, produce a low-fidelity prototype for an interactive product based upon a simple list of interaction design principles.	Usage
CO 4	To evaluate an interactive product using suitable techniques.	Usage
CO 5	To define a suitable program of user involvement that treats users ethically and fairly.	Usage

List of Experiments

S No	Topics	Hours
1	Getting familiar with Visual Studio Multiplication and Addition of any two numbers	**2**
2	Design an user interface for assigning a grade to students based on the subjects marks Design user interface for printing the numbers in Ascending order Descending order Subtraction	**2**
3	Design an user interface for calculator Design an user interface for registration of a student for admissions.	**2**
4	Design an user interface for semester registration Design an user interface for displaying and changing of a picture on the form Design an user interface for To count the number of digits in a given number	**2**
5	Design an user interface for simple sort program Design user interface	**2**
6	User interest form Making suggestion form	**2**
7	Design an user interface to check whether the year is a leap year or not Design an user interface for menu-based program	**2**
8	Design user Interfaces for ATM Machine Design user Interfaces for Socio E-commerce shop	**2**
9	Design user Interfaces for SmartPhone Design user Interfaces for Railway Reservation System	**4**
10	Design user Interfaces for Online Examination Design user Interfaces for Hospital management	**4**
11	Design user Interfaces for library management Design and User Interfaces for Hotel Booking	**4**
	Total Lab Hours	**28**

Evaluation Scheme:

S No	Exam	Coverage/Scope of Examination	Marks
1	Mid Term Test	Viva and Written Exam	20
2	End Term Test	Viva and Written Exam	20
3	Lab Records		15
4	Teacher Assessment	(Quality and quantity of experiment performed, learning laboratory skills)	30
5	Attendance and discipline in lab		15
6	Total		100

Reference Books:

- Interaction the BCS Specialist Group on Interaction
- The Usability Professionals' Association (UPA) - founded in the US, with local chapters in the US and other countries
- Mikael Ericsson's listing of research labs and projects worldwide
- Ubiquity - ACM online magazine (general IT topics, but lots relevant to HCI)
- Alan's column and resources on HCI Education in SIGCHI Bulletin
- HCI International has a bi-monthly subscription newsletter partly about the conference, but also carrying general news, events, etc. back issues at their Press Room
- Videos in User-System Interaction - collated by Matthias Rauterberg
- The HCI Bibliography - free-access online bibliographic database on Human-Computer Interaction
- HCI Resource Network - event listings, links, jobs, and subscription-only sections, includes A-Z of HCI topics
- Hans de Graaff's HCI Index
- Craig Marion's Software Design Smorgasbord
- Gary Perlman's Resources in HCI columns from Interactions
- University of Michigan HCI resource links
- The Usability First web site has good collections of resources, particularly for web and accessability
- Usability First glossary of usability terms

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

S No	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Avg
CO-1	3	3	3	2	2	3	1	1	2	1	1	3	2.1
CO-2	3	3	3	3	3	3	1	1	2	1	1	3	2.3
CO-3	3	3	3	3	3	3	1	1	2	1	1	3	2.3
CO-4	3	3	3	3	3	3	1	1	2	1	1	3	2.3
CO-5	3	3	3	3	3	3	1	1	2	1	1	3	2.3
CO-6	3	3	3	3	3	3	1	1	2	1	1	3	2.3
Avg	3	3	3	2.8	2.8	3	1	1	2	1	1	3	2.2

Cloud Computing: Concepts, Technology & Architecture

COURSE CODE: XXX
COURSE CREDITS: 2
CORE/ELECTIVE: ELECTIVE
L-T-P: 2-0-0

Pre-requisite: Knowledge of Computer Architecture, Computer Networking, and Distributed Computing.

Course Objectives:

1. To demonstrate an understanding of cloud computing concepts and standards.
2. To understand all enabling technologies of Cloud computing.
3. To discuss issues and challenges about the management of emerging cloud computing technologies and learn approaches to manage them.
4. To demonstrate the practical implementation and usage scenarios of Cloud computing.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	To learn the basic concepts, applications, and terminology of cloud computing.	Familiarity
CO-2	To learn basic concepts of infrastructure management and load balancing.	Familiarity
CO-3	To learn basic concepts of cloud security and metrics for evaluation.	Assessment
CO-4	To understand cloud computing and its role in new distributed computing implementation.	Assessment

Course Contents:

Unit	Contents	Lectures required
1	**Understanding Cloud Computing:** Basic Concepts and terminology, Goals and Benefits Risks and Challenges, Roles and boundaries, Cloud characteristics Cluster Computing, Grid Computing NIST Architecture, Cloud Deployment models Cloud service models	4
2	**Cloud Enabling Technologies:** Virtualization, Types of virtualization, Server Consolidation, virtualization management Web Technology Service-Oriented Architecture Datacenter and Multi-tenancy	4

3	**Cloud Infrastructure Management:** Cloud datacenter design, Workloads and software infrastructure for a datacenter Datacenter hardware, energy and power efficiency in a datacenter Cloud usage monitor, Monitoring agent, Resource agent, Polling Agent	**4**
4	**Cloud Mechanisms:** Automated Scaling Load Balancer SLA Monitor Failover System Multi-Cloud Broker	**5**
5	**Load Management:** Fundamental Cloud Architectures: workload distribution architecture, resource pooling architecture, dynamic scalability architecture, service load balancing architecture, cloud bursting architecture Billing Management System Business cost metrics, cloud usage cost metrics	**6**
6	**Metrics & security:** Cloud service metrics Cloud Security Mobile cloud computing Disaster recovery in cloud computing Case studies	**5**
	Total Lecture Hours	**28**

Suggested Text Book(s):

- Cloud Computing: Concepts, Technology & Architecture, by Zaigham Mahmood, Thomas Erl, Ricardo Puttini, Prentice-Hall, ISBN: 9780133387568.
- Cloud Computing Bible, by Barrie Sosinsky, Barrie Sosinsky.

Suggested Reference Book(s):

- Cloud Computing: A Practical Approach by Anthony T. Velte, Toby J. Velte, and Robert Elsenpeter; Tata McGraw – Hill Edition
- The Datacenter as a Computer – An Introduction to the Design of Warehouse Scale Machines by Luiz Andre Barroso and Urs Holzle; Morgan and Claypool Publishers
- Cloud Computing Explained: Implementation Handbook for Enterprises by John Rhoton
- The Cloud at Your Service by Jothy Rosenburg and Arthur Mateos.

Other useful resources (s):

- Link to NPTEL course contents: https://onlinecourses.nptel.ac.in/noc17_cs23/preview
- Link to topics related to course:
  - **https://www.edx.org/learn/cloud-computing**

- **https://www.udemy.com/introduction-to-cloud-computing/**
- **https://nptel.ac.in/courses/106104019/2**

Evaluation Scheme

S No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Tutorials / Assignments, Quizzes, Attendance	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs):

Course outcomes ((Cloud Computing: Concepts, Technology & Architecture)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	1.8
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	2
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	1.8
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	2.1
Average	2	2.5	2.5	2.5	2.5	1	1	1	2	2.3	1.5	2	1.9

Cloud Computing: Concepts, Technology & Architecture Lab

COURSE CODE: XXXXXXXX
COURSE CREDITS: 1
CORE/ELECTIVE: ELECTIVE
L-T-P: 0-0-2
Pre-requisite: Knowledge of Visualization, Web Service Architecture, Computer Architecture, Computer Networking, and Distributed Computing.

Course Objectives:

- To demonstrate various Visualization Platform.
- To demonstrate an understanding of cloud computing concepts and standards.
- To understand all enabling technologies for Cloud Deployment.
- To demonstrate the practical implementation and usage scenarios of Cloud computing.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO1	To learn the basic concepts, applications, and terminology of cloud computing.	Familiarity
CO2	To learn basic concepts of infrastructure management and load balancing.	Familiarity
CO3	To learn basic concepts of cloud security and metrics for evaluation.	Assessment
CO4	To understand cloud computing and its role in new distributed computing implementation.	Assessment

List of Experiments:

S No	Description	Hours
1	Introduction to Infrastructure as a Service Platforms like EC2 (AWS). Demonstrate the creation of a computing platform.	**2**
2	Demonstrate management and deployment for the IAAS platform by Remote Access platforms (Putty, remote desktop, etc).	**2**
3	Introduction to Visualization and its various types (Hypervisor type0 and type1).	**2**
4	Implementation of Visualization platforms (Sun Virtual Box, VM workstation, Zen, KVM) for Virtual Machine (VM) creation and management.	**4**
5	Implement and Management of various Virtual disk standards and VM imaging formats for Virtual Machine.	4
6	Implementation and installation of a Cloud management platform like	**4**

	open-stack / Eucalyptus etc.	
7	Creating a Warehouse Application in SalesForce.com.	4
8	Implementation and Deployment of a Platform as a Service Platform like Google App engine/ Microsoft azure etc.	**2**
9	Installation and Configuration of Hadoop.	**2**
10	Introduction to Cloud Simulation Platforms Like CloudSim and Green Cloud.	**2**
	Total Lab hours	**28**

Suggested Reference Books:

- Cloud Computing: Concepts, Technology & Architecture, by Zaigham Mahmood, Thomas Erl, Ricardo Puttini, Prentice-Hall, ISBN: 9780133387568.
- Cloud Computing Bible, by Barrie Sosinsky, Barrie Sosinsky.
- Cloud Computing: A Practical Approach by Anthony T. Velte, Toby J. Velte, and Robert Elsenpeter; Tata McGraw – Hill Edition
- The Datacenter as a Computer – An Introduction to the Design of Warehouse Scale Machines by Luiz Andre Barroso and Urs Holzle; Morgan and Claypool Publishers
- Cloud Computing Explained: Implementation Handbook for Enterprises by John Rhoton
- The Cloud at Your Service by Jothy Rosenburg and Arthur Mateos.
- Link to NPTEL course contents: https://onlinecourses.nptel.ac.in/noc17_cs23/preview
- Link to topics related to course:
  a. https://www.edx.org/learn/cloud-computing
  b. https://www.udemy.com/introduction-to-cloud-computing/
  c. https://nptel.ac.in/courses/106104019/2Ev

Evaluation Scheme:

S No	Exam	Coverage/Scope of Examination	Marks
1	Mid Term Test	Viva and Written Exam	20
2	End Term Test	Viva and Written Exam	20
3	Lab Records		15
4	Teacher Assessment	(Quality and quantity of experiment performed, learning laboratory skills)	30
5	Attendance and discipline in lab		15
6	Total		100

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	Average
CO1	3	3	3	3	2	2	1	1	1	1	1	1	1.8
CO2	3	3	3	3	3	1	1	1	1	1	1	3	2
CO3	3	3	2	3	2	3	2	1	1	1	2	1	2
CO4	3	3	3	2	3	2	1	1	1	1	1	1	1.8
Average	3	3	2.8	2.8	2.5	2	1.3	1	1	1	1.3	1.5	1.9

Cloud Computing Security

COURSE CODE: XXXXXXXX
COURSE CREDITS: 3
CORE/ELECTIVE: ELECTIVE
L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

1. Understand some of the major security challenges of cloud computing that act as a hindrance to widespread adoption.
2. Learn about some of the newer techniques that scientists are considering to protect cloud systems, their advantages, and disadvantages.
3. Learn how to critically evaluate security literature.
4. Learn how to formulate and solve a research problem in computer security and be able to present it.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	To understand the use of cloud computing	Familiarity
CO-2	A different technique to secure the cloud	Assessment
CO-3	Different types of attacks on the cloud.	Assessment
CO-4	Identify the known threats, risks, vulnerabilities and privacy issues associated with Cloud-based IT services	Usage

Course Contents:

Unit	Contents	Lectures required
1	Architectural and Technological Influences of Cloud Computing, Cloud deployment models Public, Private, Community and Hybrid models, Software as a Service (SaaS) Platform as a Service (PaaS) Infrastructure as a Service (IaaS), Cloud Computing Roles, Risks and Security Concerns	**4**
2	Guiding Security design principles for Cloud Computing, Secure Isolation, Comprehensive data protection, End-to-end access control, monitoring and auditing, Quick look at CSA, NIST and ENISA guidelines for Cloud Security, Common attack vectors and threats	**6**
3	**Secure Isolation**, Compute, Network and Storage, Common attack vectors and threats, Secure Isolation Strategies, Multitenancy, Virtualization strategies, Inter-tenant network segmentation	**6**

	strategies, Storage isolation strategies	
4	**Data Protection:** Understand the Cloud-based Information Life Cycle, Data protection for Confidentiality and Integrity, Common attack vectors and threats, Encryption, Data Redaction, Tokenization, Obfuscation, PKI and Key Management, Assuring data deletion, data retention, deletion and archiving procedures for tenant data, Data Protection Strategies	**6**
5	**Access Control for Cloud:** Understand the access control requirements for Cloud infrastructure, Common attack vectors and threats, Enforcing Access Control Strategies, Compute, Network and Storage, Authentication and Authorization, Roles-based Access Control, Multi-factor authentication, Host, storage and network access control options, OS Hardening and minimization, securing remote access, Verified and measured boot, Firewalls, IDS, IPS and honeypots	**6**
6	**Monitoring and auditing:** Proactive activity monitoring, Incident Response, Monitoring for unauthorized access, malicious traffic, abuse of system privileges, intrusion detection, events and alerts, Auditing – Record generation, Reporting, and Management, Tamper-proofing audit logs, Quality of Services, Secure Management, User management, Identity management, Security Information, and Event Management	**6**
7	**Identity Management in Cloud:** User Identification, Authentication, and Authorization in Cloud Infrastructure, Be able to understand the concepts of Identity & Access Management, Single Sign-on, Identity Federation, Identity providers and service consumers, The role of Identity provisioning	**4**
8	**Technology Review:** OpenStack Platform, Docker, Amazon Web Services	**4**
	Total Lecture Hours	**42**

Suggested Text Book(s):

- Cloud Computing Security: Foundations and Challenges John R. Vacca
- Cloud Security: A Comprehensive Guide to Secure Cloud Computing Ronald L Krutz, Russell Dean Vines

Suggested Reference Book(s):

- Securing The Cloud: Cloud Computing Security Techniques and Tactics by Vic (J.R.) Winkler

- Cloud Computing Design Patterns by Thomas Erl (Prentice Hall)

Other useful resources (s):

- http://www.cs.colostate.edu/~cs656/

Evaluation Scheme:

S No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered up to T-1
2	T-2	25	1.5 Hours	Syllabus covered up to T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Cloud Computing Security)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	1.8
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	2
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	1.8
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	2.1
Average	2	2.5	2.5	2.5	2.5	1	1	1	2	2.3	1.5	2	1.9

Information Security

COURSE CODE: XXX
COURSE CREDITS: 2
CORE/ELECTIVE: Elective
L-T-P: 2-0-0

Pre-requisite: None

Course Objectives:

1. Investigation of core security technologies and security policies to mitigate risks.
2. Gain an understanding of network perimeter security design principles
3. Gain an understanding of free/ commercial security tools and their applications and develop the security solution for a given application/scenario.
4. Ability to review procedures for installation, troubleshooting, and monitoring of network devices to maintain integrity, confidentiality, and availability of data and devices.
5. Knowledge of the technologies that underpin the deployment and maintenance of a secure network.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	Understand the need for security	Familiarity
CO-2	Analysis of security algorithms	Assessment
CO-3	Demonstrate familiarity with major security algorithms and data structure.	Assessment
CO-4	Apply important security algorithmic design paradigms and methods of analysis.	Usage

Course Contents:

Unit	Contents	Lectures required
1	**Symmetric Encryption** Shift Cipher, Substitution Cipher, Vigen`ere Cipher, A Permutation Cipher Introduction To Symmetric Ciphers, Stream Cipher Basics, The Lorenz Cipher, Linear Feedback Shift Registers, Combining LFSRs, RC4	5
2	Introduction To Block Ciphers, Feistel Ciphers and DES, Rijndael, Modes of Operation Key Management, Secret Key Distribution, Formal Approaches to Protocol Checking Hash Functions, Designing Hash Functions, Message Authentication Codes	5

3	**Public Key Encryption and Signatures** Public Key Cryptography Candidate One-way Functions, RSA, ElGamal Encryption, Rabin Encryption, Paillier Encryption Diffie–Hellman Key Exchange, Digital Signature Schemes, The Use of Hash Functions In Signature Schemes, The Digital Signature Algorithm, Schnorr Signatures, Nyberg–Rueppel Signatures	**5**
4	**Attacks on Public-Key Schemes** Wiener's Attack on RSA, Lattices and Lattice Reduction, Lattice-Based Attacks on RSA, Partial Key Exposure Attacks	**5**
5	**Provable Security:** Security of Signature Algorithms, Security of Encryption Algorithms, Hybrid Ciphers, Signature Schemes, Encryption Algorithms	**4**
6	**Advanced Protocols:** Access Structures, General Secret Sharing, Reed–Solomon Codes, Shamir Secret Sharing, Commitment Schemes, Oblivious Transfer, Showing a Graph Isomorphism in Zero-Knowledge, Zero-Knowledge and NP, Sigma Protocols	**4**
	Total Lecture Hours	**28**

Suggested Text Book(s):

- Cryptography: An Introduction, Nigel Smart
- Cryptography and Network Security: Principles and Practice William Stallings

Suggested Reference Book(s):

- A.J. Menezes, P. van Oorschot, and S.A. Vanstone. The Handbook of Applied Cryptography.

Evaluation Scheme:

S No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered up to T-1
2	T-2	25	1.5 Hours	Syllabus covered up to T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Information Security)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	1.8
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	2
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	1.8
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	2.1
Average	2	2.5	2.5	2.5	2.5	1	1	1	2	2.3	1.5	2	1.9

Information Security Lab

COURSE CODE: XXX
COURSE CREDITS: 1
CORE/ELECTIVE: ELECTIVE
L-T-P: 0-0-2

Pre-requisite: None
Course Objectives:

1. To understand the basic security algorithms
2. To Implement various symmetric cipher
3. To implement various public-key encryption algorithms

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO1	Understand the basic security services e.g. Authentication, Access Control, Confidentiality, Integrity	Familiarity
CO2	Learn standard symmetric encryption algorithms	Assessment
CO3	Learn architecture for public and private key cryptography.	Assessment
CO4	Learn the methods of digital signature and encryption.	Assessment
CO5	Learn key management and how key exchange protocols work.	Uses
CO6	Learn futuristic cryptographic techniques like Elliptic Curve and quantum cryptography	Assessment

List of Experiments

S No	Description	Hours
1	Study of Network Security fundamentals - Ethical Hacking, Social Engineering practices.	**2**
2	Study of System threat attacks - Denial of Services	**2**
3	Study of Sniffing and Spoofing attacks	**2**
4	Study of Techniques uses for Web-Based Password Capturing	**2**
5	Study of Different attacks causes by Virus and Trojans	**2**
6	Study of Anti-Intrusion Technique – Honey pot	**2**
7	Study of Symmetric Encryption Scheme – RC4	**4**
8	Implementation of S-DES algorithm for data encryption	**4**
9	Implementation of Asymmetric Encryption Scheme – RSA.	**4**
10	Study of IP based Authentication	**4**
	Total Lab hours	**28**

Suggested/Resources:

- Atual Kahate, " Cryptography and Network Security", TMH.
- William Stalling, " Cryptography and Network Security", Pearson.

Evaluation Scheme:

S No	Exam	Coverage/Scope of Examination	Marks
1	Mid Term Test	Viva and Written Exam	20
2	End Term Test	Viva and Written Exam	20
3	Lab Records		15
4	Teacher Assessment	(Quality and quantity of experiment performed, learning laboratory skills)	30
5	Attendance and discipline in lab		15
6	Total		100

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Avg
CO1	3	3	3	3	2	2	1	1	1	1	1	1	1.8
CO2	3	3	3	3	3	1	1	1	1	1	1	3	2
CO3	3	3	2	3	2	3	2	1	1	1	2	1	2
CO4	3	3	3	2	3	2	1	1	1	1	1	1	1.8
CO5	2	2	3	3	3	3	1	1	1	1	1	1	1.8
CO6	2	3	3	3	2	2	2	2	2	2	2	2	2.3
Avg	2.7	2.8	2.8	2.8	2.5	2.2	1.3	1.2	1.2	1.2	1.3	1.5	2

Game Development and Design

Course Name: Game Development and Design
Course Code: XXX
Course Credits: 2
CORE/ELECTIVE: ELECTIVE
Prerequisite: Knowledge of programming language (Python, C++,

Course Objective(s): To introduce students to the novel concepts of game development and design with special emphasis on its applications in diverse fields and current research.

Course Outcomes:

S No	Course outcomes	Level of Attainment
CO-1	Game Theory Introduction with Various Theorem	Familiarity
CO-2	Introduction of Nash Equilibrium, Bounded Rationality, Strategic Games, Strictly competitive Games	Assessment
CO-3	Methods to solve the Strategic Games with Matrix 2-person Games, 3-person Games	Assessment
CO-4	Introduction of Matrix Games & Linear Programming methods to solve complex Games	Assessment
CO-5	Design the games using by analyzing the Mixed Strategy Nash Equilibrium	Assessment
CO-6	Analysis of Game complexity by finite repeated & infinite repeated games	Assessment
CO-7	Design the Games with timeliness and restrict the strategies	Assessment
CO-8	Learn the games complexity by NASH FOLK Theorem	Usage
CO-9	Analyze the Game Design with best response & equality of pay-off	Usage

Course Contents:

Unit	Chapters	Lectures Required
1	**Introduction:** Game Theory, The theory of rational choice, Theory of Competitive Equilibrium, steady State and Deductive Interpretations, Bounded Rationality Terminology and Notation Nash Equilibrium- Strategic Games, Nash Equilibrium Examples Existence of a Nash Equilibrium, Strictly Competitive Games, Bayesian Games: Strategic Games with Imperfect Information	**6**
2	**Matrix Two-Person Games**(The Basics, The von Neumann Minimax Theorem, Mixed Strategies, Solving 2 × 2 Games Graphically, Graphical Solution of 2 × m and n × 2 Games, Best Response Strategies	**4**
3	**Solution Methods for Matrix Games:** Solution of Some Special	**5**

	Games, Invertible Matrix Games,Symmetric Games, Matrix Games and Linear Programming, Two-Person Nonzero Sum Games(The Basics, 2 × 2 Bimatrix Games, Best Response, Equality of Payoffs,	
4	**Mixed Strategy Nash Equilibrium** Interpretations of Mixed Strategy Nash Equilibrium Correlated Equilibrium Evolutionary Equilibrium Rationalizability and Iterated Elimination of Dominated Actions-Rationalizability Iterated Elimination of Strictly Dominated Actions, Iterated Elimination of Weakly Dominated Actions	**5**
5	**Repeated Games:** The Basic Idea Infinitely Repeated Games vs.\ Finitely Repeated Games Infinitely Repeated Games: Definitions Strategies as Machines Trigger Strategies: Nash Folk Theorems Punishing for a Limited Length of Time	**6**
6	**Game Examples:** 8 Queen Game, Sudoku Puzzle Game, Chess Board Game	**2**
	Total Lecture Hours	**28**

Text Book(s):

- Games Theory An Introduction second edition by E. N Barron Loyola University Chicago Chicago, Illinois

Reference Book(s):

- An Introduction to Game Theory by Martin J. Osborne
- Introduction to Game Theory by StefTijs Tilburg University Tilburg, Hindustan Book Agency(India)
- Games of Strategy Theory And Application by Melvin Dresher Prentice – Hall, Inc. Englewood Cliffs, N.J.

Evaluation Scheme:

S No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered up to T-1
2	T-2	25	1.5 Hours	Syllabus covered up to T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Tutorials / Assignments, Quizzes, Attendance	25	Entire Semester	Assignment - 9 Quizzes - 12 Attendance - 4

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

S No	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Avg
CO-1	3	2	3	1	2	3	3	2	1	2	2	2	2.2
CO-2	3	3	3	1	2	3	3	3	2	2	2	2	2.4
CO-3	3	3	3	1	2	3	2	3	2	2	3	3	2.5
CO-4	3	3	3	3	2	3	3	2	2	2	3	3	2.7
CO-5	3	3	3	2	2	3	3	3	2	2	3	3	2.7
CO-6	3	3	3	2	2	2	3	2	2	2	2	2	2.3
CO-7	3	3	3	2	2	2	2	2	2	2	3	2	2.3
CO-8	3	3	3	3	2	3	3	2	2	2	3	3	2.7
CO-9	3	3	3	3	2	3	3	3	2	2	3	2	2.7
Avg	3	2.9	3	2	2	2.8	2.8	2.4	1.9	2	2.7	2.4	2.5

Game Development Lab

COURSE CODE: XXX
COURSE CREDITS: 1
CORE/ELECTIVE: ELECTIVE
L-T-P: 0-0-2
Pre-requisite: Introduction to Computer Programming C ,C++, Matlab
Course Objectives:

1. To strengthen their problem-solving ability by applying logic & numerical approach.
2. To strengthen the ability to design and represent solutions to problems using Nash Equilibrium and saddle points.
3. To introduce the 2-Person, N-Person Game, Mixed Strategy, Convex Combination

Course Outcomes:

S.No.	Course outcomes	Level of Attainment
CO-1	To explain how the game is implemented through a matrix representation	Familiarity
CO-2	To analyze and decompose the problem into matrix & propose the various solutions using Nash Equilibrium, Mixed Strategy.	Assessment
CO-3	To design the game for 2-person, N-person e.g. Puzzle Game, Chess Board,8 Queen Game	Assessment

List of Experiments

S.No.	Description	Hours
1	There are 100 bankers lined up in each of 100 rows. Pick the richest banker in each row. Javier is the poorest of those. Pick the poorest banker in each column. Raoul is the richest of those. Who is richer: Javier or Raoul	**2**
2	Implement Mixed Strategy Problem & find out the expected payoff	**2**
3	Implement the Mixed strategy Problem and find the saddle point for finite & infinite user	**2**
4	Consider the game with matrix $\begin{bmatrix} 3 & -2 & 4 & 7 \\ -2 & 8 & 4 & 0 \end{bmatrix}$. Solve the game, find the best response for player1 to the strategy$(\frac{1}{4},\frac{1}{2},\frac{1}{8},\frac{1}{8})$. What is 2nd best response to 1st best response?	**2**
5	Consider the game	**2**

	$\begin{matrix}1 & -3 & -5 & 1\\ 0 & 4 & 4 & -2\\ 0 & 0 & 8 & 3\\ 0 & 0 & 0 & 50\end{matrix}$ Solve this game by finding v(A) and the optimal strategies.	
6	Consider the matrix for two-player $\begin{bmatrix}1{,}0 & 1{,}3 & 3{,}0\\ 0{,}2 & 0{,}1 & 3{,}0\\ 0{,}2 & 2{,}4 & 5{,}3\end{bmatrix}$ Find the Nash Equilibrium	**2**
7	Consider the matrix $\begin{bmatrix}1{,}1 & 3,\mathrm{x} & 2{,}0\\ 2\mathrm{x},3 & 2{,}2 & 3{,}1\\ 2{,}1 & 1,\mathrm{x} & \mathrm{x}^2,4\end{bmatrix}$ Find x so that the game has exactly two pure Nash equilibrium?	**2**
8	Consider the game in which each player has two strategies Wait and Go. The game matrix is $\begin{bmatrix}1{,}1 & 1-€,2\\ 2{,}1-€ & 0{,}0\end{bmatrix}$ Find the correlated equilibria corresponding to the Nash equilibria 0<€<1	**2**
9	Implement the prisoner's dilemma game with matrix	**2**
10	The third column of the matrix $\begin{bmatrix}0 & 8 & 5\\ 8 & 4 & 6\\ 12 & -4 & 3\end{bmatrix}$ is dominated by a convex combination. Reduce the matrix and solve the game.	**2**
11	Use dominance to solve the following game even though it has no inverse $\mathrm{A}=\begin{bmatrix}-4 & 2 & -1\\ -4 & 1 & 4\\ 0 & -1 & 5\end{bmatrix}$	**2**
12	Design the magic Square game. A Game has a matrix in which each row has a row sum that is the same as each of the column sums. For example $\mathrm{A}=\begin{bmatrix}11 & 24 & 7 & 20 & 3\\ 4 & 12 & 25 & 8 & 16\\ 17 & 5 & 13 & 21 & 9\\ 10 & 18 & 1 & 14 & 22\\ 23 & 6 & 19 & 2 & 15\end{bmatrix}$	**2**
13	Design the 9×9 Sudoku puzzle game	**2**
14	Implement the chessboard for 2 users and find the optimal strategy	**2**
	Total Lab Hours	**28**

Evaluation Scheme:

S No	Exam	Coverage/Scope of Examination	Marks
1	Mid Term Test	Viva and Written Exam	20
2	End Term Test	Viva and Written Exam	20
3	Lab Records		15
4	Teacher Assessment	(Quality and quantity of experiment performed, learning laboratory skills)	30
5	Attendance and discipline in lab		15
6	Total		100

Reference Books

- An Introduction to Game Theory by Martin J. Osborne
- Introduction to Game Theory by Stef Tijs Tilburg University Tilburg, Hindustan Book Agency(India)
- Games of Strategy Theory and Application by Melvin Dresher Prentice – Hall, Inc. Englewood Cliffs, N.J.

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

CO/PO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	2	2	2	3	1	1	1	1	1	2	2	1.8
CO-2	3	3	3	3	3	2	1	2	2	1	2	3	2.3
CO-3	3	3	2	3	3	2	1	2	2	1	2	3	2.3
Average	3	2.8	2.5	2.8	3	1.8	1	1.8	1.8	1	2	2.8	

Information Auditing and Risk Management

Course Name: Information Auditing and Risk Management
Course Code: XXXXXX
Course Credits: 3-0-0
CORE/ELECTIVE: ELECTIVE
Prerequisite: NIL

Course Objectives

- Targets project leaders involved in managing risk in capital projects.
- Providing a robust introduction of Enterprise Risk Management (ERM) and the ISO 31000 risk management standard.
- Exploring the practical processes involved in identifying, and evaluating internal and external risks to an organization.

Course Outcomes:

S No	Course outcomes	Level of Attainment
CO-1	To learn to explain why it is important to design interactive products that are usable, define key terms used in interaction design	Familiarity
CO-2	To learn to explain key theories used in the design of interactive products and to explain the importance of iteration, evaluation, and prototyping in interaction design	Familiarity
CO-3	To gather data in the context of developing a simple interactive product using suitable techniques	Assessment
CO-4	To produce a low-fidelity prototype for an interactive product based upon a simple list of interaction design principles and to evaluate an interactive product using suitable techniques	Assessment
CO-5	To communicate effectively to peers and specialists about requirements, design, and evaluation activities relating to interactive products	Usage
CO-6	To define a suitable program of user involvement that treats users ethically and fairly.	Usage

Course Contents:

Unit	Topic	Lectures Required
1	Introduction: Overview of course objectives and agenda, Interactive exercise – participants will complete a survey on the level of maturity of project risk management in their organization. Introduction to the Construction Industry Institute's Risk Management best practice area and its role in improving project performance	**4**
2	Risk Management Process: Introduction to risk management Owner and contractor perspectives on risk, The risk management process, Applying	**8**

	risk management throughout the project lifecycle, Roles and responsibilities	
3	Risk Identification: Major sources of risk, Risk identification methods – brainstorming, structured interviews, documentation review and risk checklists	**6**
4	Supporting tools: Risk Register template, Risk Breakdown Structure(RBS), Construction-focused Risk Checklist, Using the Risk Register template to document identified risks	**10**
5	Risk Assessment: The assessment process for identified risks, Selecting an appropriate risk assessment level for each project, Level 1 – Risk Identification, Level 2 – Probability & Impact	**4**
6	Utilizing the **Risk Assessment tables**, Recording assessment results in the Risk Register	**5**
7	Risk Response: Developing risk response plans and actions, Risk response strategies, Examples of "actionable" risk responses, Project contingency	**3**
8	Risk Monitoring: Tracking and reporting risks using the Risk Register, Monitoring existing risks and execution of risk response plans and actions, Integrating risk status into regular project communications and reporting	**2**
	Total Lecture Hours	**42**

Reference Books

- Risk Management, The Blackford Centre.
- Fundamentals of Risk Management: Understanding, Evaluating and Implementing Effective Risk Management
- Operational Risk Management: Best Practices in the Financial Services Industry

Evaluation Scheme:

S No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

CO/PO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	3	1	2	3	3	2	1	1	1	3	2.2
CO-2	3	2	1	2	1	1	2	3	2	1	1	3	1.8
CO-3	3	3	3	3	2	1	2	2	2	1	1	2	2.1
CO-4	3	3	2	3	2	1	2	3	2	1	1	2	2.1
CO-5	3	3	3	3	2	1	2	3	2	1	1	3	2.3
CO-6	3	3	3	3	2	1	2	3	2	1	1	3	2.3
Average	3	2.8	2.5	2.5	1.8	1.3	2.2	2.7	1.8	1	1	2.7	2.1

Information Modeling

COURSE CODE: XXX
COURSE CREDITS: 3
CORE/ELECTIVE: ELECTIVE
L-T-P: 3-0-0
Pre-requisite: Database systems, Data Mining
Course Objectives:

1. Learn to build an information modeling.
2. Learn the Concept of data and process modeling.
3. Learn the Concept of Component modeling.
4. Apply information modeling techniques to solve real-life problems.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	Understand the basics of information modeling application and their usages in different areas	Familiarity
CO-2	To be familiar with the basics of various modeling techniques	Familiarity
CO-3	Ability to apply modeling techniques on real-life scenarios to solve them easily	Assessment
CO-4	Ability to apply information modeling with Linked data	Usage

Course Contents:

Unit	Contents	Lectures Required
1	**Information Model:** Introduction, needs; Components of the information model. **Information Modeling:** Introduction: Why? What? How? Goals; Concepts; Information Modeling Vs Data Modeling.	**8**
2	**Data Modeling:** Introduction; Workflow of Data Modeling; Data Modeling Notations and Languages; Data Modeling Concepts; Challenges in Data Modeling.	**6**
3	**Meta Modeling:** Introduction; Concepts; Requirements on Metamodeling Notations; IRDS - Information Resource Dictionary Standard; Repositories; Introduction to Ontology; Analyzing and Comparing Ontologies with Meta-Models.	**7**
4	**Process Modeling:** Introduction; Workflow Management; Process Modeling; Workflow Management System; Executing Processes; Information Delivery Manuals and Model View Definitions.	**6**

5	**Data, Ontology, and Component Modelling:** A Taxonomic Class Modelling Methodology for Object-Oriented Analysis; Comprehension of Hierarchical ER Diagrams Compared to Flat ER Diagrams; Constraints on Conceptual Join Paths; A Service-Oriented Component Modelling Approach; Evaluation of Component-Based Development Methods.	**7**
6	**Information Modelling and Linked Data:** Introduction; Concepts of Linked Data and the Semantic Web; Technology: The Semantic Web Stack; Multiple Interlinked Models; Dynamic, Semantic Model Extensions; Querying and Reasoning	**8**
	Total Lecture Hours	**42**

Suggested Text Book(s):

- John Krogstie (SINTEF, Norway), Terry Halpin (Neumont University, USA), and Keng Siau (Missouri University of Science and Technology, USA): Information Modeling Methods and Methodologies: Advanced Topics in Database Research, IGI-Global, August 2004.
- André Borrmann, Markus K¨onig, Christian Koch, Jakob Beetz: Building Information Modeling, Springer,

Suggested Reference Book(s):

- Charrel, Pierre-Jean; Jaakkola, Hannu; Kangassalo, Hannu; Kawaguchi, Eiji: Information Modelling and Knowledge Bases, Frontiers in artificial intelligence and applications,

Evaluation Scheme:

S No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered up to T-1
2	T-2	25	1.5 Hours	Syllabus covered up to T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	1	1	1	2	1	1	1	1	1	2	3	1.4
CO-2	3	1	1	2	2	1	1	1	1	1	2	3	1.6
CO-3	2	2	2	3	3	2	1	1	2	1	3	3	2.1
CO-4	3	2	3	3	3	2	1	1	1	1	3	3	2.2
Average	2.5	1.5	1.8	2.3	2.5	1.5	1	1	1.3	1	2.5	3	1.8

Ethics and Information Technology

COURSE CODE: XXX
COURSE CREDITS: 3
CORE/ELECTIVE: ELECTIVE
L-T-P: 3-0-0
Pre-requisite: None
Course Objectives:

1. The course will discuss the social impacts of computers in information technology.
2. Students will be given a broad overview of relevant topics to include free speech, privacy, security and the law
3. Understand the importance of ethical issues that emerge from the widespread use of information technology.
4. Professional and ethical responsibilities based on community values and the law will be discussed.
5. This course will focus on the economic, social, cultural, and global impacts of decisions that are made relating to information technology.
6. Understand the ethical issues associated with confidentiality and privacy as they relate to information technology.
7. Students will become familiar with organizations, laws, and regulations related to computer ethics and individual conduct in cyberspace.
8. Students will apply critical thinking skills to evaluate cyber ethics issues.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	Demonstrate knowledge of current models of information and computer ethics.	Familiarity
CO-2	Apply ethical theories to interpret personal and group behavior when using a variety of information technology tools.	Assessment
CO-3	Evaluate the nature of ethical choices made by self and others when serving various roles that expose social and multicultural differences.	Assessment
CO-4	Construct written arguments in a variety of formats on the evolving nature of ethical norms relating to new technologies	Usage

Course Contents:

Unit	Contents	Lectures required
1	**Introduction:** Defining key terms: Cyber ethics and Cyber technology, Four Developmental Phases in Cyber technology, Are Cyber ethics Issues Unique Ethical Issues? Digital Piracy, Cyber ethics as a Branch of	**5**

	Applied Ethics: Three Distinct Perspectives, A Comprehensive Strategy for Approaching Cyber ethics Issues, Ethics, and Morality.	
2	**Ethical Concepts and Critical Thinking:** Discussion of various scenarios: The "Runaway Trolley": A Classic Moral Dilemma, A Controversial Policy in America, A Dilemma Involving Conflicting Duties, Character-Based Ethical Theories, Integrating Aspects of Classical Ethical Theories into a Single Comprehensive Theory, Constructing an Argument: Valid Arguments, Sound Arguments, Invalid Arguments, Inductive Arguments, Fallacious Arguments, A Seven-Step Strategy for Evaluating arguments, Identifying some common fallacies.	**6**
3	**Professional Ethics and Privacy:** Professional Ethics, Safety-Critical Software, Professional Codes of Ethics and Codes of Conduct, Conflicts of Professional Responsibility: Employee Loyalty and Whistle-Blowing, Moral, Responsibility, Legal Liability, and Accountability, Risk Assessment in the Software Development Process, Do Some Computer Corporations Have Special Moral Obligations? **Privacy:** Personal privacy, Importance of Privacy, Gathering Personal Data: Monitoring, Recording, and Tracking Techniques Exchanging Personal Data: Merging and Matching Electronic Records, Mining Personal Data, Protecting Personal Privacy in Public Space, Privacy-Enhancing Technologies, Privacy Legislation, and Industry Self-Regulation.	**6**
4	**Security in Cyberspace:** Security in the context of cyber technology, Three categories of cybersecurity, Hacking, and "The Hacker Ethic, Cyberterrorism, Information Warfare(IW), Cybersecurity and Risk Analysis.	**5**
5	**Cyber Crime:** Cybercrimes and Cybercriminals, Hacking, Cracking, and Counterhacking, Defining Cybercrime, Three Categories of Cybercrime: Piracy, Trespass, and Vandalism in Cyberspace, Cyber-Related Crimes, Technologies and Tools for Combating Cybercrime, National and International Laws to Combat Cybercrime. Various scenarios: Virtual Casino, Prosecuting a Computer Corporation in Multiple Countries, The Pirate Bay Web Site, Are WikiLeaks' Practices Criminal? **Intellectual property:** What is Intellectual Property?Copyright law and Digital Media, Patents, Trademarks, and Trade Secrets, Jurisdictional Issues Involving Intellectual Property Law, Philosophical Foundations for Intellectual Property Rights, The Free Software and the Open Source Movements,	**8**
6	**Regulating Commerce:** Background Issues and Some Preliminary Distinctions, Four Modes of Regulation: The Lessing Model, Digital Rights Management and the Privatization of Information Policy, The Use and Misuse of (HTML) Metatags and Web Hyperlinks, Email-Spam, Free Speech vs. Censorship and Content Control in Cyberspace, "Network Neutrality" and the Future of Internet Regulation. algorithms.	**6**

7	**Community in CyberSpace:** Online Communities and Social Networking Services, Virtual Environments and Virtual Reality, Cyber Identities and Cyber Selves, AI, and its implications.	**4**
8	**Ethical aspects of emerging technologies:** Converging Technologies and Technological Convergence, Bioinformatics and Computational Genomics, Nanotechnology and Nano Computing, Autonomous Machines and Machine Ethics, A "Dynamic" Ethical Framework for Guiding Research in New and Emerging Technologies.	**2**
	Total Lecture Hours	**42**

Suggested Text Book(s):

- Tavani, H.T. (2010). Ethics and technology: Controversies, questions, and strategies in ethical computing (3rd ed.) Massachusetts, John Wiley & Sons Inc. [ISBN: 978-0-470-50950-0].

Suggested Reference Book(s):

- Blackley, J. A., Peltier, J., & Peltier, T. (2003) Information Security Fundamentals, 1st ed. Boca Raton, FL. Auerbach Publications. [ISBN: 0849319579/9780849319570].

Evaluation Scheme:

S No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered up to T-1
2	T-2	25	1.5 Hours	Syllabus covered up to T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Ethics and Information Technology)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	**1.8**
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	**2**
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	**1.8**
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	**2.1**
Average	**2**	**2.5**	**2.5**	**2.5**	**2.5**	**1**	**1**	**1**	**2**	**2.3**	**1.5**	**2**	

Knowledge-Based AI: Cognitive Systems

COURSE CODE: XXX
COURSE CREDITS: 3
CORE/ELECTIVE: ELECTIVE
L-T-P: 3-0-0
Pre-requisite: Discrete Mathematics, Programming Languages

Course Objectives:
The course aims to familiarize the students with the basic concepts as well as with the state-of-the-art research literature in knowledge-based artificial intelligence. After successful completion of this course, students will be able to:

1. Understand concepts, methods, and prominent issues in knowledge-based artificial intelligence
2. Learn specific skills and abilities needed to apply those concepts to the design of knowledge-based AI agents
3. Understand the relationship between knowledge-based artificial intelligence and the study of human cognition.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	Understanding the basic concepts of knowledge-based AI & Cognitive Systems	Familiarity
CO-2	Understanding various fundamental concepts & techniques related to AI as well as cognitive systems.	Familiarity
CO-3	Learning & implementing various reasoning methods such as common sense reasoning, analogical reasoning, etc	Usage
CO-4	Designing & creating as well as metacognition knowledge	Assessment

Course Contents:

Unit	Contents	Lectures Required
1	**Introduction:** Introduction to KBAI & Cognitive Systems, Where Knowledge-Based AI fits into AI as a whole - Cognitive systems: what are they? - AI and cognition: how are they connected?	**5**
2	**Fundamentals:** Semantic Networks - Generate & Test - Means-Ends Analysis - Problem Reduction - Production Systems	**5**
3	**Common Sense Reasoning**: Frames - Understanding - Common Sense Reasoning - Scripts	**4**
4	**Planning & Learning:** Logic, Planning, Learning by Recording Cases - Incremental Concept Learning - Classification - Version	**6**

	Spaces & Discrimination Trees	
5	**Analogical Reasoning:** Case-Based Reasoning - Explanation-Based Learning - Analogical Reasoning	**5**
6	**Visuospatial Reasoning:** Constraint Propagation - Visuospatial Reasoning	**5**
7	**Design & Creativity:** Configuration - Diagnosis - Design - Creativity	**6**
8	**Metacognition:** Learning by Correcting Mistakes - Meta-Reasoning - AI Ethics	**6**
	Total Lecture Hours	**42**

Suggested Text Book(s):

- "Artificial Intelligence: A Modern Approach", Stuart Russell and Peter Norvig, 3rd Edition
- "Artificial Cognitive Systems: A Primer", David Vernon, 1st Edition

Suggested Reference Book(s):

- "Artificial Intelligence by Example", Denis Rothman

Other useful resources (s):

1. Link to NPTEL course contents:
   - https://nptel.ac.in/courses/106/105/106105077/
2. Link to topics related to course:
   - https://www.youtube.com/watch?v=0Alhb1HDsNw
   - https://www.youtube.com/watch?v=JMUxmLyrhSk
   - https://www.udacity.com/course/knowledge-based-ai-cognitive-systems--ud409

Evaluation Scheme:

S No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered up to T-1
2	T-2	25	1.5 Hours	Syllabus covered up to T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Program Outcomes (POs)

Course outcomes (Knowledge-Based AI: Cognitive Systems)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	1.8
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	2
CO-3	2	2	3	3	3	1	1	1	2	2	1	2	1.9
CO-4	2	3	3	3	2	1	1	1	2	3	1	2	2
Average	2	2.5	2.8	2.8	2.5	1	1	1	2	2.3	1.3	2	1.9

Reinforcement Learning

COURSE CODE: XXX
COURSE CREDITS: 3
CORE/ELECTIVE: ELECTIVE
L-T-P: 3-0-0
Pre-requisite: Probability & Statistics, Machine Learning

Course Objectives:
The course aims to familiarize the students with the basic concepts as well as with the state-of-the-art research literature in deep reinforcement learning. After successful completion of this course, students will be able to:

1. Structure of a reinforcement learning problem
2. Understand and apply basic RL algorithms for simple sequential decision-making problems in uncertain conditions.
3. Evaluate the performance of the solution
4. Interpret state-of-the-art RL research and communicate their results.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	Understanding the basic concepts of Reinforcement Learning	Familiarity
CO-2	Understanding Probability Primer Techniques in detail.	Familiarity
CO-3	Learning & implementing various methods & techniques such as TD methods, Monte Carlo, Markov Decision Process, etc.	Usage
CO-4	Learning & understanding policy gradients along with its advantages and disadvantages.	Assessment

Course Contents:

Unit	Contents	Lectures Required
1	**Introduction:** Origin and history of Reinforcement Learning research. Its connections with other related fields and with different branches of machine learning.	**2**
2	**Probability Primer:** Axioms of probability, concepts of random variables, PMF, PDFs, CDFs, Expectation. Concepts of joint and multiple random variables, joint, conditional and marginal distributions. Correlation and independence.	**4**
3	**Markov Decision Process:** Introduction to RL terminology, Markov property, Markov chains, Markov reward process (MRP). Introduction to and proof of Bellman equations for MRPs along with proof of existence of solution to Bellman equations in MRP. Introduction to Markov decision	**6**

	process (MDP), state and action value functions, Bellman expectation equations, optimality of value functions and policies, Bellman optimality equations.	
4	**Prediction & Control by Dynamic Programming:** Overview of dynamic programming for MDP, definition and formulation of planning in MDPs, principle of optimality, iterative policy evaluation, policy iteration, value iteration, Banach fixed point theorem, proof of contraction mapping property of Bellman expectation and optimality operators, proof of convergence of policy evaluation and value iteration algorithms, DP extensions.	**6**
5	**Monte Carlo methods for Model Free Prediction & Control :** Overview of Monte Carlo methods for model free RL, First visit and every visit Monte Carlo, Monte Carlo control, On policy and off policy learning, Importance sampling.	**6**
6	**TD Methods:** Incremental Monte Carlo Methods for Model Free Prediction, Overview TD(0), TD(1) and TD(λ), k-step estimators, unified view of DP, MC and TD evaluation methods, TD Control methods - SARSA, Q-Learning and their variants.	**6**
7	**Function Approximation Methods:** Getting started with the function approximation methods, Revisiting risk minimization, gradient descent from Machine Learning, Gradient MC and Semi-gradient TD(0) algorithms, Eligibility trace for function approximation, After states, Control with function approximation, Least squares, Experience replay in deep Q-Networks.	**6**
8	**Policy Gradients:** Getting started with policy gradient methods, Log-derivative trick, Naive REINFORCE algorithm, bias and variance in Reinforcement Learning, Reducing variance in policy gradient estimates, baselines, advantage function, actor-critic methods.	**6**
	Total Lecture Hours	**42**

Suggested Text Book(s):

- "Reinforcement Learning: An Introduction", Richard S. Sutton and Andrew G. Barto, 2nd Edition
- "Probability, Statistics, and Random Processes for Electrical Engineering", 3rd Edition, Alberto Leon-Garcia

Suggested Reference Book(s):

- "Machine Learning: A Probabilistic Perspective", Kevin P. Murphy

Other useful resources (s):

1. Link to NPTEL course contents:
   - https://nptel.ac.in/courses/106/106/106106143/
2. Link to topics related to course:

- https://www.youtube.com/watch?v=JgvyzIkgxF0
- https://www.youtube.com/watch?v=LzaWrmKL1Z4

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered up to T-1
2	T-2	25	1.5 Hours	Syllabus covered up to T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Program Outcomes (POs)

Course outcomes (Reinforcement Learning)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	2	2	2	2	1	2	1.8
CO-2	2	3	3	3	3	1	3	2	2	2	1	2	2.3
CO-3	2	3	3	3	3	2	3	2	2	2	1	2	2.3
CO-4	2	3	3	3	2	1	2	3	2	3	2	2	2.3
Average	2	2.8	2.8	2.8	2.5	1.3	2.5	2.3	2	2.3	1.3	2	2.2

Architecting Distributed Cloud Applications

COURSE CODE: XXX
COURSE CREDITS: 2
CORE/ELECTIVE: ELECTIVE
L-T-P: 2-0-0
Pre-requisite: Cloud Computing, Distributed applications, Basic networking concepts.
Course Objectives:

1. To understand cloud distributed applications.
2. To know the benefits and challenges of microservices architecture.
3. To learn the fundamentals of service endpoints, scalability, and availability.
4. To know the fundamentals of messaging with queues.
5. To understand best practices for managing service configuration.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	Introduction to cloud computing and distributed cloud applications	Familiarity
CO-2	Network Communication in distributed cloud applications	Assessment
CO-3	Message Communication in distributed cloud applications	Assessment
CO-4	Versioning, upgrading, and configuration of distributed cloud applications	Usage

Course Contents:

Unit	Contents	Lectures Required
1	**Module 1:** **Cloud Computing Introduction:** Cloud computing definition, benefits of cloud computing. What are cloud applications, why develop cloud applications, what are orchestrators and containers in the cloud, the difference between orchestrators and containers? What are micro-services, why convert monolith applications to micro-services, micro-service architectural myths, auto-scaling of cloud microservices?	5
2	**Module 2: Network Communication** Network issues for distributed cloud applications, service endpoint scalability, and availability, forward and reverse proxies, cluster DNS, reverse proxy load balancers. What are service APIs for distributed cloud applications? Fault-tolerant network communication, circuit breaking.	4
3	**Module 3:Messiging Communication** What is message communication, benefits of message communication,	4

	messing with queues, fault-tolerant messaging process, some queue features?	
4	**Module 4: Versioning, upgrading, and configuration** Service update options, rolling updates feature, shutting down a service, gracefully shutting down a service, service configuration, and reconfiguration.	**4**
5	**Module 5: Leader Election** What is leader election, why we need leader, main roles, and responsibilities of a leader, leader election via lease, leader election via queue messages?	**5**
6	**Module 6: Storage Services** Introduction to data storage services, data temperature, object storage services, database storage services, backup restore, and disaster recovery.	**6**
	Total Lecture Hours	**28**

Suggested Text Book(s):

- Cloud Computing: Concepts, Technology & Architecture, by Zaigham Mahmood, Thomas Erl, Ricardo Puttini, Prentice-Hall, ISBN: 9780133387568
- Wilder, B. (2012). Cloud architecture patterns: using Microsoft azure. " O'Reilly Media, Inc.".

Suggested Reference Book(s):

- Srinivasan, V., Ravi, J., & Raj, J. (2018). Google Cloud Platform for Architects: Design and manage powerful cloud solutions. Packt Publishing Ltd.

Other useful resources (s):

This course is designed based on a famous course provided by Microsoft. Links to courses and content are as follows:

- https://courses.edx.org/courses/course-v1:Microsoft+DEVOPS200.9x+3T2019/course/
- https://azure.microsoft.com/en-in/blog/architecting-distributed-cloud-applications-free-video-course/
- https://www.youtube.com/watch?v=xJMbkZvuVO0&list=PL9XzOCngAkqs0Q8ZRdafnSYExKQurZrBY

EvaluationScheme:

S No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes(2) -10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Architecting Distributed Cloud Applications)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	2	1	1	1	1	1	1	1	1	1	1.4
CO-2	3	3	3	2	2	1	1	1	1	1	3	1	1.8
CO-3	3	3	3	2	2	2	1	1	1	1	3	1	1.9
CO-4	3	3	3	2	2	1	1	1	1	1	3	1	1.8
Average	3	3	2.8	1.8	1.8	1.3	1	1	1	1	2.5	1	1.8

Architecting Distributed Cloud Application Lab

COURSE CODE: XXXXX
COURSE CREDITS: 1
CORE/ELECTIVE: ELECTIVE
L-T-P: 0-0-2
Pre-requisite: Cloud Computing, Basic Networking

Course Objectives:

1. Learn to create a VM on the Microsoft Azure cloud.
2. Create Docker and install container on the docker.
3. Learn to run a network, communication, and storage services for cloud applications on containers.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO1	Install Docker and container. Deploy virtual machine on Microsoft Azure.	Familiarity
CO2	Create sample microservice on cloud container	Usage
CO3	Perform messaging service on cloud containers	Usage
CO4	Learn about storage service on cloud containers	Usage

List of Experiments

S No	Description	Hours
1	Deploy a Microsoft Azure Virtual Machine using free account. Create an account on Visual Studio Team Services (VSTS).	4
2	Install Docker on Ubuntu Machine.	4
3	Create a container image and run the container	4
4	Build a Sample Application with Microservices	4
5	Message Communication of Distributed Cloud Applications	4
6	Storage Services for Distributed Cloud Applications	4
7	Small Project using cloud application services	4
	Total Lab hours	**28**

Suggested/Resources:
This course is designed based on famous course provided by Microsoft. Links to courses and content are as follows:

- https://courses.edx.org/courses/course-v1:Microsoft+DEVOPS200.9x+3T2019/course/
- https://azure.microsoft.com/en-in/blog/architecting-distributed-cloud-applications-free-video-course/

- https://www.youtube.com/watch?v=xJMbkZvuVO0&list=PL9XzOCngAkqs0Q8ZRdafnSYExKQurZrBY

Evaluation Scheme:

S No	Exam	Coverage/Scope of Examination	Marks
1	Mid Term Test	Viva and Written Exam	20
2	End Term Test	Viva and Written Exam	20
3	Lab Records		15
4	Teacher Assessment	(Quality and quantity of experiment performed, learning laboratory skills)	30
5	Attendance and discipline in lab		15
6	Total		100

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Average
CO1	3	3	2	1	1	1	1	1	1	1	1	1	1.4
CO2	3	3	3	2	2	1	1	1	1	1	3	1	1.8
CO3	3	3	3	2	2	2	1	1	1	1	3	1	1.9
CO4	3	3	3	2	2	1	1	1	1	1	3	1	1.8
Average	3	3	2.8	1.8	1.8	1.3	1	1	1	1	2.5	1	1.8

Optimization Methods in Business Analytics

COURSE CODE: XXX
COURSE CREDITS: 3
CORE/ELECTIVE: ELECTIVE
L-T-P: 3-0-0

Pre-requisite: Algorithm design
Course Objectives:

1. Learn the analytics of optimizing algorithms.
2. Learn various computing algorithms in solving complex problems.
3. Apply important algorithmic design paradigms and methods of analysis.
4. Synthesize efficient algorithm design in common engineering design situations.
5. Learn to analyze the specifications and sensitivity of the algorithms.
6. Learn the improvisations of algorithms.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	Comprehension of the design of the optimized algorithm.	Familiarity
CO-2	Demonstrate familiarity with major algorithms.	Assessment
CO-3	Analyze the different types of algorithms.	Assessment
CO-4	Apply algorithms for simulating the decision.	Usage

Course Contents:

Unit	Contents	Lectures Required
1	**Introduction to optimization technique:** Examples of optimization problems: Shortest path problem, integer knapsack; Unconstrained optimization; Unconstrained optimization; Convex set and Convex function; Duality: Geometric interpretation, Lagrangian Saddle point, Weak and strong duality.	8
2	**Linear programming:** Linear programming problem; Basic feasible solution; Geometric solution; Optimality condition and simplex method; Two-phase simplex method; Interior point method, Duality in linear programming, Karmarkars method.	8
3	**Transportation problem:** Characteristics of transportation problem; Northwest Corner Method; Least Cost Method; Vogel's Approximation Method **Assignment problem:** Characteristics of assignment problem, Hungarian methods, Dual of assignment problem, optimality of Hungarian methods.	6

4	**Integer programming:** Complexity of simplex methods**;** Elementary notions; Formulation; Solving 0-1 problem; Branch-Bound for integer programming; Cutting plane problem; All integer primal and Dual algorithm;	**8**
5	**Network models:** Characteristics of network models; Shortest path problem; Successive shortest path problem; Maximum flow problem; Minimum cost flow problem.	**6**
6	**Nonlinear programming:** Quadratic programming: Lagrange multiplier and KKT, Steepest descent method. **Sensitivity analysis:** dummy variable, linear programming, integer linear programming, nonlinear models and statistical test: t-test, chi-square test, Wilcoxon signed-rank	**6**
	Total Lecture Hours	**42**

Suggested Text Book(s):

- Singiresu S. Rao, Engineering Optimization: Theory and Practice by John Wiley and Sons, 4th edition, 2009.
- H. S. Kasane & K. D. Kumar, Introductory Operations Research, Springer (India), Pvt. Ltd., 2004
- Optimization for Engineering Design. K Deb.

Suggested Reference Book(s):

- Sheskin, David J. (2003) Handbook of Parametric and Nonparametric Statistical Procedures. CRC Press.
- Optimization concepts and applications in engineering, A. D. Belegundu and T. R. Chandrupatla.
- Linear and Nonlinear programming. Stephen G. Nash and A. sofer

Other useful resources (s):

- Link to NPTEL course contents: https://nptel.ac.in/courses/111/105/111105039/
- Link to NPTEL course contents: https://nptel.ac.in/courses/111/104/111104068/
- Link to NPTEL course contents: https://nptel.ac.in/courses/112/106/112106131/

Link to topics related to course:

- https://nptel.ac.in/courses/112/106/112106134/
- https://nptel.ac.in/courses/112/106/112106131/
- https://nptel.ac.in/courses/106104019/26
- https://nptel.ac.in/courses/111/105/111105039/

Evaluation Scheme:

S No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Optimization Methods in Business Analytics)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	1.8
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	2
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	1.8
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	2.1
Average	2	2.5	2.5	2.5	2.5	1	1	1	2	2.3	1.5	2	1.9

From Graph to Knowledge Graph

COURSE CODE: XXX
COURSE CREDITS: 2
CORE/ELECTIVE: ELECTIVE
L-T-P: 2-0-0
Pre-requisite: Basic programming skills
Course Objectives:

1. You will learn graph representations.
2. Understand the entire process of how to design, construct, and query a knowledge graph to solve real-world problems.
3. Understand how to apply the tools and infrastructure to build and query knowledge graphs.
4. Use knowledge graphs in modern search applications.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	Learn graph representations	Familiarity
CO-2	Utilize fundamentals to build knowledge graphs	Assessment
CO-3	Understand the algorithms and techniques for crawling web sites, structured data extraction, and information extraction from unstructured text.	Assessment
CO-4	Understand how to apply the tools and infrastructure to build and query knowledge graphs.	Usage

Course Contents:

Unit	Contents	Lectures Required
1	Introduction and Overview Introduction to Graphs, Introduction to Knowledge graphs	**4**
2	Graph Properties and Applications: Graph basics, Graph Applications	**4**
3	Graph Representation Learning Embeddings and Graph Embeddings	**4**
4	Knowledge Graph (KG) - Fundamentals and Construction. KG Fundamentals How to Build a Knowledge Graph	**5**
5	Knowledge Graph (KG) - Inference and Applications KG Inference. How to Use a Knowledge Graph Why We Need Knowledge Graphs: Applications KG Applications	**6**
6	Knowledge graph analytics	**5**
	Total Lecture Hours	**28**

Suggested Text Book(s):

- Fensel, Dieter (et al.), "Knowledge Graphs Methodology, Tools and Selected Use Cases", Springer, 2020.
- Qi, G. et. al, "Knowledge Graph", Springer, 2020, ISBN 978-981-10-8177-4

Suggested Reference Book(s):

- Jeff Z. Pan, Guido Vetere, Jose Manuel Gomez-Perez, Honghan Wu, " Exploiting Linked Data and Knowledge Graphs in Large Organisations", Springer International Publishing, Print ISBN 978-3-319-45652-2, DOI https://doi.org/10.1007/978-3-319-45654-6
- Mayank Kejriwal, "Domain-Specific Knowledge Graph Construction", Springer, DOI: 10.1007/978-3-030-12375-8

Other useful resources (s):

- Journal, "Knowledge-Based Systems", Springer

Evaluation Scheme:

S No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (From Graph to Knowledge Graph)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	1.8
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	2
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	1.8
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	2.1
Average	2	2.5	2.5	2.5	2.5	1	1	1	2	2.3	1.5	2	1.9

From Graph to Knowledge Graph Lab

COURSE CODE: XXX
COURSE CREDITS: 1
CORE/ELECTIVE: ELECTIVE
L-T-P: 0-0-2
Pre-requisite: Basic programming skills

Course Objectives:

1. The lab is designed to provide a versatile means to perform learning tasks over a knowledge graph.
2. Use Machine Learning over a Knowledge Graph

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO1	Build a knowledge graph from documents	Usage
CO2	Building a knowledge graph from a text	Usage
CO3	Build a Small Knowledge Graph	Usage
CO4	Understand the Graph Databases	Assessment
CO5	Familiarity with graph computing Frameworks	Familiarity
CO6	Able to Visualization of graphs	Assessment

List of Experiments

S No	Description	Hours
1	Introduction to Linked Data. Loan Prediction Practice Problem (Using Python) Build a knowledge graph from documents	4
2	Build a Small Knowledge Graph Creating and Processing Linked Data Building a knowledge graph from text A Knowledge Graph understanding and implementation	4
3	Build a Small Knowledge Graph Building a knowledge graph in python from scratch	4
4	Introduction to Graph Databases A Python Library for Knowledge Graph Embedding	6
5	Introduction to graph computing Frameworks	4
6	Introduction to Graph Visualization	6
	Total Lab hours	**28**

Suggested/Resources:

- Grakn KGLIB (Knowledge Graph Library) https://github.com/.
- Online resources.

- Fensel, Dieter (et al.), "Knowledge Graphs Methodology, Tools and Selected Use Cases", Springer, 2020.

Evaluation Scheme:

S No	Exam	Coverage/Scope of Examination	Marks
1	Mid Term Test	Viva and Written Exam	20
2	End Term Test	Viva and Written Exam	20
3	Lab Records		15
4	Teacher Assessment	(Quality and quantity of experiment performed, learning laboratory skills)	30
5	Attendance and discipline in lab		15
6	Total		100

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Avg
CO1	3	3	3	3	2	2	1	1	1	1	1	1	**1.83**
CO2	3	3	3	3	3	1	1	1	1	1	1	3	**2.00**
CO3	3	3	2	3	2	3	2	1	1	1	2	1	**2.00**
CO4	3	3	3	2	3	2	1	1	1	1	1	1	**1.83**
CO5	2	2	3	3	3	3	1	1	1	1	1	1	**1.83**
C06	2	3	3	3	2	2	2	2	2	2	2	2	**2.25**
Avg	**2.67**	**2.83**	**2.80**	**2.80**	**2.60**	**2.20**	**1.20**	**1.00**	**1.00**	**1.00**	**1.20**	**1.40**	

Probabilistic Graphical Models

COURSE CODE: XXX
COURSE CREDITS: 3
CORE/ELECTIVE: ELECTIVE
L-T-P: 3-0-0
Pre-requisite: Machine learning and Probability
Course Objectives:

1. Learn introductory concepts in probabilistic graphical models.
2. Able to model problems using graphical models.
3. Able to model problems using design inference algorithms.
4. Learn the structure of the graphical model from data

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	Learn introductory concepts in probabilistic graphical models	Familiarity
CO-2	Able to model problems using graphical models.	Assessment
CO-3	Able to model problems using design inference algorithms.	Assessment
CO-4	Analyze the structure of the graphical model from data	Usage

Course Contents:

Unit	Contents	Lectures Required
1	**Fundamentals I**: Fundamentals of Probability Theory - Views of Probability, Random Variables and Joint Distributions, Conditional Probability, Conditional Independence, Expectation and Variance, Probability Distributions - Conjugate Priors, Introduction to Exponential Family;	**3**
2	**Fundamentals II**: Fundamentals of Graph Theory – Nodes and Edges, Paths and Trails, Cliques, Subgraphs, Cycles, and Loops.	**3**
3	**Graphical Models** I: Introduction - Directed Models (Bayesian Network), Undirected Models (Markov Random Fields), Dynamic Models (Hidden Markov Model & Kalman Filters) and Factor Graph;	**6**
4	**Graphical Models II**: Conditional Independence (Bayes Ball Theorem and D-separation), Markov Blanket, Factorization (Hammersley-Clifford Theorem), Equivalence (I-Maps & Perfect Maps); Factor Graphs - Representation, Relation to Bayesian Network and Markov Random Field.	**6**
5	**Inference in graphical models I**: Exact Inference - Variable Elimination, Elimination Orderings, Relation to Dynamic Programming, Dealing with Evidence, Forward-Backward Algorithm, Viterbi Algorithm; Junction Tree Algorithm; Belief Propagation (Sum-Product);	**6**

6	**Inference in graphical models I** I: Approximate Inference - Variational Methods (Mean Field, Kikuchi & Bethe Approximation), Expectation Propagation, Gaussian Belief Propagation; MAP Inference - Max-Product, Graph Cuts, Linear Programming Relaxations to MAP (Tree-Reweighted Belief Propagation, MPLP); Sampling - Markov Chain Monte Carlo, Metropolis Hastings, Gibbs (Collapsing & Blocking), Particle filtering	**6**
7	**Learning in Graphical Models I:** Overview, Parameter Estimation - Expectation Maximization, Maximum Likelihood Estimation, Maximum Entropy, Pseudolikelihood, Bayesian Estimation, Conditional Likelihood,	**6**
8	**Learning in Graphical Models II:** Structured Prediction; Learning with Approximate Inference; Learning with Latent Variables; Structure Learning, Structure Search, L1 priors.	**6**
	Total Lecture Hours	**42**

Suggested Text Book(s):

- Koller, D. and Friedman, N. (2009). Probabilistic Graphical Models: Principles and Techniques. MIT Press.

Suggested Reference Book(s):

- Jensen, F. V. and Nielsen, T. D. (2002). Bayesian Networks and Decision Graphs. Information Science and Statistics. Springer, 2nd edition.
- Kevin P. Murphy (2013) Machine Learning: A Probabilistic Perspective. 4th Printing. MIT Press.
- Barber, D. (2011). Bayesian Reasoning and Machine Learning. Cambridge University Press, 1st edition.
- Bishop, C. M. (2011). Pattern Recognition and Machine Learning (Information Science and Statistics). Springer, 2nd printing.
- Wainwright, M. and Jordan, M. (2008). Graphical Models, Exponential Families, and Variational Inference. Foundations and Trends in Machine Learning, 1:1–305.

Other useful resource(s):

- Conference papers and journal articles

Evaluation Scheme:

S No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Probabilistic Graphical Models)	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**Average**
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	**1.75**
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	**2**
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	**1.75**
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	**2.08**
Average	**2**	**2.5**	**2.5**	**2.5**	**2.5**	**1**	**1**	**1**	**2**	**2.25**	**1.5**	**2**	1.89

Image Analysis and Pattern Recognition

COURSE CODE: XXX
COURSE CREDITS: 2
CORE/ELECTIVE: ELECTIVE
L-T-P: 2-0-0

Pre-requisites: Linear algebra, Matrices, Matrix Operations, Determinants, Systems of Linear Equations, Eigenvalues, Eigenvectors, Statistics and probability, Programming experience, preferably in MATLAB, and/or C/C++/C#/Python/Java

Course Objective:
The course aims to introduce the student to various image processing techniques. The student learns about image fundamentals, describes the main characteristics of digital images, how they are represented, mathematical transforms such as Fourier, Cosine transforms, Singular value decomposition, 2D Wavelet transform, image enhancement techniques, Image restoration and denoising, segmentation, lossy and lossless data compression algorithms, binary and color image processing. The student will be exposed to dealing with image data through programming assignments using MatLab, and/or C/C++/C#/Python/Java.

Course Outcome:
Upon completion of this course, a successful student should be able to design and implement programs that deal with image data.

- To understand how digital images are represented, manipulated, encoded, and processed, with emphasis on algorithm design, implementation, and performance evaluation.
- Emphasis will be to develop engineering skills and intuitive understanding of the tools used in Image Processing.
- The students would be encouraged to design and develop the image processing algorithms/tools for real-life problems.

Course Outcomes:

S No	Course outcomes	Level of Attainment
CO-1	To understand the different images and their processing	Familiarity
CO-2	To understand the concept of Image transformation Algorithms/techniques	Assessment
CO-3	To understand the concepts of lossy and Lossless compression Algorithms/techniques	Assessment
CO-4	To understand the concepts of Image enhancement and Segmentation Algorithms/techniques	Assessment
CO-5	To understand the concepts of Image Restoration and Denoising Algorithms/techniques	Technical skills
CO-6	To understand the concepts of Binary and Color image processing	Assessment

CO-7	To understand the concepts of Object recognition decision-theoretic methods and structural methods	Technical skills

Course contents:

Unit	Topic	Lectures required
1	**Introduction to Digital Image Processing** Introduction to images and its processing, Components of image processing systems, image representations, Image file formats, Applications of digital image processing, image sampling, and quantization, Image Analysis, Intensity transformations, contrast stretching, Correlation, and convolution, Smoothing filters, sharpening filters, gradient, and Laplacian.	3
2	**Image Transformation Techniques** Need for transform, Fourier, Cosine transforms, Haar, KL Transform, Singular value decomposition, 2D Wavelet transform, Different properties of image transform techniques.	4
3	**Image Compression Basics** Concept of image compression, lossless techniques (Huffman Coding, Arithmetic, and Lempel-Ziv Coding, Other Coding Techniques) and lossy compression techniques (Transform Coding & K-L Transforms, Discrete Cosine Transforms, and BTC), Multi-Resolution Analysis, and Still Image Compression Standards (JBIG and JPEG),	4
4	**Image Enhancement** **Enhancement in spatial and transform domain,** histogram equalization DirectionalSmoothing, Median, Geometric mean, Harmonic mean, Contrahar monic mean filters, Homomorphic filtering, Color image enhancement.	3
5	**Image Restoration and Denoising** Image degradation, Type of image blur, Classification of image restoration techniques, image restoration model, Linear, and non-linear restoration techniques, Image denoising, Median filtering	3
6	**Image Segmentation** **Classification of image segmentation techniques,** Boundary detection based techniques, Point, line detection, Edge detection, Edge linking, local processing, regional processing, Hough transform, Thresholding, Iterative thresholding, Otsu's method, Moving averages, Multivariable thresholding, Region-based segmentation, Watershed algorithm, Use of motion in segmentation	4
7	**Binary and Color image processing** Binarization, Basic Set theory, Binary morphological operations, and its properties, Color Image Representation in MATLAB, Converting Between Color Spaces, The Basics of Color Image Processing, Color Transformations, Spatial Filtering of Color Images, Working Directly in RGB Vector Space	3
8	**Object Recognition** **Decision theoretic methods:** Matching, Optimal statistical Classifier, Neural network.	4

	Structural methods: Matching shape numbers, String matching, Syntactic recognition of string, Syntactic recognition of tree.	
	Total Lecture Hours	**28**

Recommended Books

- Digital Image Processing, R.C. Gonzalez and R.E. Woods, 2nd edition, Pearson Prentice Hall, 2008
- Anil K. Jain, *Fundamentals of Digital Image Processing*, Prentice-Hall, 1989.
- Digital Image processing, S Jayaraman, TMH, 2012
- William K. Pratt, *Digital Image Processing*, 3rd Edition, John Wiley, 2001.

Evaluation Scheme:

S No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Avg
CO1	3	3	3	2	3	3	2	2	2	2	2	3	2.5
CO2	3	3	3	2	2	2	2	2	2	2	2	3	2.3
CO3	3	3	3	2	3	2	2	2	2	2	2	3	2.4
CO4	3	3	3	2	3	2	2	2	2	2	2	3	2.4
CO5	3	3	3	2	3	2	2	2	2	2	2	3	2.4
CO6	3	3	3	2	3	2	2	2	2	2	2	3	2.4
CO7	3	3	3	3	3	3	2	2	3	2	3	3	2.8
Avg	3	3	3	2.1	2.9	2.3	2	2	2.1	2	2.1	3	2.5

Image Analysis and Pattern Recognition Lab

COURSE CODE: XXX
COURSE CREDITS: 1
CORE/ELECTIVE: ELECTIVE
L-T-P: 0-0-2

Pre-requisite: programming, algorithm, matrix operations
Course Objectives: In this lab, you will implement image processing techniques that you will learn during the frontal course. Work in the lab will be carried out in Matlab and OpenCV

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO1	Introduction to basic image processing operations and histogram algorithms	Familiarity
CO2	Introduction to image filtering in spatial and in frequency domains.	Assessment
CO3	Introduction to image restoration.	Assessment
CO4	Introduction of principles of the JPEG baseline coding system.	Assessment
CO5	Getting familiar with the OpenCV library. Basic processing of color images and introduction to video tracking using the Camshaft algorithm.	Technical skills
CO6	Analyze the systems using Laplace transform and Z-transform.	Assessment

List of Experiments

S No	Description	Hours
1	Introduction to MATLAB. In this lab, we will study basic image-processing operations: image resizing and rotation, quantization, and histogram algorithms. We will analyze the effects of resizing and quantization on image quality and the methods to improve the quality and avoid artifacts. Histogram techniques allow us to analyze the distribution of gray levels in an image. In this lab, we will study histogram, histogram normalization, and histogram equalization. Understand the basics of MATLAB syntax, functions, and programming.	**4**
2	In this lab, we'll study the properties of DFT and two practical applications: 1. Computation of convolution by two methods – direct method (in the spatial domain) and indirect method (in the frequency domain). 2.Computation of edge enhancement by unsharp masking.	**4**
3	In practical imaging systems, the acquired image often suffers from the effects of blurring and noise. Image restoration algorithms are aimed to restore the original undistorted image from its blurry and noisy version. The lab experiment demonstrates the evolution of restoration algorithms from the simple Inverse Filter, Pseudo Inverse Filter, and Wiener Filter	**4**
	Mid sem exam	**2**

4	In this lab, we will present the basic concepts used for JPEG coding and experiment with different coding parameters. The JPEG standard provides a powerful compression tool used worldwide for different applications. This standard has been adopted as the leading lossy compression standard for natural images due to its excellent compression capabilities and its configurability.	**4**
5	OpenCV is an open-source computer vision library, written in C and C++. One of the main goals of OpenCV is to provide a simple-to-use computer vision infrastructure that helps people to build sophisticated vision applications quickly. Among the tools provided by OpenCV are image transformations, histograms, video tracking, 3D vision algorithms, and machine learning.	**4**
6	Implementation of Camshaft algorithm, Mean-shift algorithm and Adaptive adjustment	**4**
	End-semester Exam	**2**
	Total Lab hours	**28**

Suggested/Resources:

- R. C. Gonzalez, R. E. Woods and S. L. Eddins, *Digital Image Processing using MATLAB*. Pearson Education, Inc., 2004 (Library Dewey number 621.368 GON).
- OpenCV library: http://SourceForge.net/projects/opencvlibrary

Evaluation Scheme:

S No	Exam	Coverage/Scope of Examination	Marks
1	Mid Term Test	Viva and Written Exam	20
2	End Term Test	Viva and Written Exam	20
3	Lab Records		15
4	Teacher Assessment	(Quality and quantity of experiment performed, learning laboratory skills)	30
5	Attendance and discipline in lab		15
6	Total		100

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Avg
CO1	3	3	3	3	2	2	1	1	1	1	1	1	1.8
CO2	3	3	3	3	3	1	1	1	1	1	1	3	2
CO3	3	3	2	3	2	3	2	1	1	1	2	1	2
CO4	3	3	3	2	3	2	1	1	1	1	1	1	1.8
CO5	2	2	3	3	3	3	1	1	1	1	1	1	1.8
CO6	2	3	3	3	2	2	2	2	2	2	2	2	2.3
Avg	2.7	2.8	2.8	2.8	2.5	2.2	1.3	1.2	1.2	1.2	1.3	1.5	2

Statistics and Exploratory Data Analytics

COURSE CODE: XXX
COURSE CREDITS: 2
CORE/ELECTIVE: ELECTIVE
L-T-P: 2-0-0
Pre-requisite: None
Course Objectives:

1. Learn the basic concept of statistics and exploratory data analysis.
2. Learn graphical and modeling techniques for exploring data.
3. Learn Data Transformation and dimensionality reduction of data.
4. Learn data clustering and scatter plots.
5. Apply exploratory data analysis techniques to visualized data.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	Analyze the concept of statistics and exploratory data analysis.	Familiarity
CO-2	Graphical and modeling techniques for exploring data.	Assessment
CO-3	Implement data transformation, dimensionality reduction	Assessment
CO-4	Apply data clustering and visualized exploratory data through various plots and graphs.	Usage

Course Contents:

Unit	Contents	Lectures required
1	**Concept of statistics and exploratory data analysis:** Introduction of data and its types (categorical and quantitative), Central Tendency: mean, median, mode, variance, standard deviation, skewness, kurtosis, exploratory data analysis, and its types, data dimensionality.	**5**
2	**Graphical and modeling techniques for exploratory data:** Box Plot, Histogram, Multi-Vari Chart, Run Chart, Pareto Chart, Scatter Plot, Stem-and-leaf plot.	**5**
3	**Data transformation, dimensionality reduction**: Power transformation, standardization, multidimensional scaling, principal component analysis, linear or non-linear dimensionality reduction.	**7**
4	**Data Clustering Techniques:** Data clustering, Hierarchal methods, optimization method, k-means, and model-based clustering.	**5**
5	**Smoothing scatter plots and graphical methods for EDA:** Bivariate distribution smooths, curve fitting toolbox, Dendrogram, treemaps, rectangle plots.	**6**
	Total Lecture Hours	**28**

Suggested Text Book(s):

- Martinez, W. L.; Martinez, A. R. & Solka, J. (2010). *Exploratory Data Analysis with MATLAB, second edition*. Chapman & Hall/CRC.
- Hoaglin, D C; Mosteller, F & Tukey, John Wilder (Eds) (1983). *Understanding Robust and Exploratory Data Analysis*.
- Andrienko, N & Andrienko, G (2005) *Exploratory Analysis of Spatial and Temporal Data. A Systematic Approach*

Suggested Reference Book(s):

- Tukey, John Wilder (1977). *Exploratory Data Analysis*. Addison-Wesley

Evaluation Scheme:

S No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Statistics and Exploratory Data Analytics)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	1.8
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	2
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	1.8
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	2.1
Average	2	2.5	2.5	2.5	2.5	1	1	1	2	2.3	1.5	2	1.9

Statistics and Exploratory data analytics Lab

COURSE CODE: XXX
COURSE CREDITS: 1
CORE/ELECTIVE: ELECTIVE
L-T-P: 0-0-2
Pre-requisite: Basic knowledge of python programming and Matlab.
Course Objectives:

1. Learn to explore a dataset
2. Visualization of data
3. Dimensionality reduction of data
4. Cluster findings in a dataset
5. Usage of curve fitting tools

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO1	Understand the basics of MATLAB syntax/python libraries	Familiarity
CO2	Exploring dataset and visualizing data on different charts.	Assessment
CO3	Perform the basic operations of data pre-processing and dimensionality reduction.	Assessment
CO4	Design and analyze clustering techniques.	Usage
CO5	Understanding of curve fitting toolbox.	Usage
CO6	Implementation of dendrogram and treemaps.	Usage

List of Experiments

S No	Description	Hours
1	Introduction to MATLAB/Python Libraries	**2**
2	Exploring dataset and data preprocessing	**2**
3	Importing dataset in python	**2**
4	Implementation of standard deviation and skewness of data	**2**
5	Visualizing data on a histogram	**2**
6	Implementations of the box plot chart	**2**
7	Implementation of data representation in the pie chart	**2**
8	Implementation of data representation in scatter plot	**2**
9	Implementation of a column chart	**2**
10	Implementation of principal component analysis techniques	**2**
11	Implementation of nonlinear dimensionality reduction	**2**
12	Finding cluster in a dataset	**2**
13	Implementation of hierarchal clustering techniques	**2**
14	Implementation of curve fitting toolbox	**2**
	Total Lab hours	**28**

Suggested/Resources:

- Martinez, W. L.; Martinez, A. R. & Solka, J. (2010). *Exploratory Data Analysis with MATLAB, second edition*. Chapman & Hall/CRC.
- Hoaglin, D C; Mosteller, F & Tukey, John Wilder (Eds) (1983). *Understanding Robust and Exploratory Data Analysis.*

Evaluation Scheme:

S No	Exam	Coverage/Scope of Examination	Marks
1	Mid Term Test	Viva and Written Exam	20
2	End Term Test	Viva and Written Exam	20
3	Lab Records		15
4	Teacher Assessment	(Quality and quantity of experiment performed, learning laboratory skills)	30
5	Attendance and discipline in lab		15
6	Total		100

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Avg
CO1	3	3	3	3	2	2	1	1	1	1	1	1	**1.83**
CO2	3	3	3	3	3	1	1	1	1	1	1	3	**2.00**
CO3	3	3	2	3	2	3	2	1	1	1	2	1	**2.00**
CO4	3	3	3	2	3	2	1	1	1	1	1	1	**1.83**
CO5	2	2	3	3	3	3	1	1	1	1	1	1	**1.83**
C06	2	3	3	3	2	2	2	2	2	2	2	2	**2.25**
Avg	**2.67**	**2.83**	**2.80**	**2.80**	**2.60**	**2.20**	**1.20**	**1.00**	**1.00**	**1.00**	**1.20**	**1.40**	

Information Visualization

COURSE CODE: XXX
COURSE CREDITS: 3
CORE/ELECTIVE: ELECTIVE
L-T-P: 3-0-0
Pre-requisite: Basic mathematics courses

Course Objectives:

1. Information visualization offers instruments for reasoning about quantitative information, analyzing, and communicating statistical information.
2. The course overviews the main typologies of data graphics (data-maps, time-series, space-time narrative, relational diagrams, graphs and methods for dimensionality reduction)
3. The course provides a language for discussing data visualizations combined with knowledge of the human perception of visual objects.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	Big Data and Large-Scale Computation, Web Technologies	Familiarity
CO-2	Applications and Science, Signal Processing and Data Science tracks	Assessment
CO-3	Game Design and Production and Machine Learning, Data Science and Artificial Intelligence majors	Assessment
CO-4	Machine Learning, Data Science and Artificial Intelligence, Analytics and Data Science minor.	Usage
CO-5	ICT Innovation program's Data Science, Digital Media Technology, Human-Computer Interaction minor, and Life Science Technologies Complex Systems major and minor and Bioinformatics and Digital Health minor.	Usage

Course Contents:

Unit	Contents	Lectures required
1	**Foundations for an Applied Science of Data Visualization:** Visualization Stages, Experimental Semiotics Based on Perception, Semiotics of Graphics, Sensory versus Arbitrary Symbols, Gibson's Affordance Theory, A Model of Perceptual Processing, Costs and Benefits of Visualization, Types of Data, Metadata	**6**
2	**The Environment, Optics, Resolution, and the Display:** The Environment, The Eye, The Optimal Display	**4**
3	**Lightness, Brightness, Contrast, and Constancy:** Neurons, Receptive Fields, and Brightness Illusions, Luminance, Brightness, Lightness, and	**4**

	Gamma, Perception of Surface Lightness, Monitor Illumination and Monitor Surrounds	
4	**Color:** Trichromacy Theory, Color Measurement, Opponent Process Theory, Properties of Color Channels, Color Appearance, Applications of Color in Visualization	**4**
5	**Visual Salience and Finding Information:** Eye Movements, V1, Channels, and Tuned Receptors, Preattentive Processing and Ease of Search, Integral and Separable Dimensions: Glyph Design, Representing Quantity, The Searchlight Metaphor and Cortical Magnification	**6**
6	**Static and Moving Patterns:** Gestalt Laws, Texture: Theory and Data Mapping, Perception of Transparency: Overlapping Data, Perceiving Patterns in Multidimensional Discrete Data, Pattern Learning, The Visual Grammar of Node–Link Diagrams, The Visual Grammar of Maps, Patterns in Motion, Perception of Animated Motion, The Processes of Pattern Finding	**6**
7	**Space Perception:** Depth Cue Theory, Depth Cues in Combination, Task-Based Space Perception, Tracing Data Paths in 3D Graphs, Judging the Morphology of Surfaces, Patterns of Points in 3D Space, Perceiving Patterns in 3D Trajectories, Judging Relative Positions of Objects in Space, Judging the Relative Movements of Self within the Environment, Selecting and Positioning Objects in 3D, Judging the "Up" Direction, The Aesthetic Impression of 3D Space (Presence)	**6**
8	**Visual Objects and Data Objects:** Image-Based Object Recognition, Structure-Based Object Recognition, The Object Display, and Object-Based Diagrams, Faces, Coding Words and Images, Labels and Concepts, Concept Mapping, Iconic Images versus Words versus Abstract Symbols, Scenes and Scene Gist	**6**
Total lectures		**42**

Suggested Text Book(s):

- Ware, C., 2020. Information visualization: perception for design. Morgan Kaufmann.

Suggested Reference Book(s):

- Bederson, B.B., Bederson, B.B., and Shneiderman, B. eds., 2003. The craft of information visualization: readings and reflections. Morgan Kaufmann.
- Bergman, E. ed., 2000. Information appliances and beyond: interaction design for consumer products. Morgan Kaufmann.

Other useful resources (s):

- https://www.youtube.com/watch?v=t0B2sxIumh0&list=PLk_jmmkw5S2C1A_ZD3mpBb3Og_Y1QZ83Z
- https://www.youtube.com/watch?v=IKSRwGZe8Oc

Evaluation Scheme:

S No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes(2) -10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Information Visualization)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	1.8
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	2
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	1.8
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	2.1
CO-5	2	3	3	3	2	1	1	1	2	3	2	2	2.1
Average	2	2.6	2.6	2.6	2.4	1	1	1	2	2.4	1.6	2	

Introduction to Deep Learning

COURSE CODE: XXX
COURSE CREDITS: 3
CORE/ELECTIVE: ELECTIVE
L-T-P: 3-0-0
Pre-requisite:
1) Basic knowledge of Python.
2) Basic linear algebra and probability.

Course Objectives:

1. The goal of this course is to give learners a basic understanding of modern neural networks and their applications in computer vision and natural language understanding.
2. The course starts with a recap of linear models and discussion of stochastic optimization methods that are crucial for training deep neural networks.
3. Learners will study all popular building blocks of neural networks including fully connected layers, convolutional and recurrent layers.
4. Learners will use these building blocks to define complex modern architectures in TensorFlow and Keras frameworks.
5. In the course, project learner will implement a deep neural network for the task of image captioning which solves the problem of giving a text description for an input image.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	Linear regression: mean squared error, analytical solution.	Familiarity
CO-2	Logistic regression: model, cross-entropy loss, class probability estimation	Assessment
CO-3	Gradient descent for linear models. Derivatives of MSE and cross-entropy loss functions.	Assessment
CO-4	The problem of overfitting.	Usage
CO-5	Regularization for linear models.	Usage

Course Contents:

Unit	Contents	Lectures Required
1	**Introduction to optimization:** Linear regression, Linear classification Gradient descent, Overfitting problem and model validation, Model regularization, Stochastic gradient descent, Gradient descent extensions9m	**8**

2	**Introduction to neural networks:** Multilayer perceptron (MLP), Chain rule, Backpropagation, Efficient MLP implementation, Other matrix derivatives, what is TensorFlow, our first model in TensorFlow, What Deep Learning is and is not, Deep learning as a language	**8**
3	**Deep Learning for images:** Motivation for convolutional layers11m Our first CNN architecture, Training tips and tricks for deep CNNs, Overview of modern CNN architectures, Learning new tasks with pre-trained CNNs, A glimpse of other Computer Vision tasks8m	**6**
4	**Unsupervised representation learning:** Unsupervised learning: what it is and why bother, Autoencoders 10, Autoencoder applications, Autoencoder applications: image generation, data visualization & more, Natural language processing primer, Word embeddings, Generative models 10, Generative Adversarial Networks, Applications of adversarial approach	**6**
5	**Deep learning for sequences:** Motivation for recurrent layers, Simple RNN and Backpropagation, The training of RNNs is not that easy, Dealing with vanishing and exploding gradients, Modern RNNs: LSTM and GRU, Practical use cases for RNNs	**8**
6	**Final Project:** This week you will apply all your knowledge about neural networks for images and texts for the final project. You will solve the task of generating descriptions for real-world images!	**6**
	Total Lecture Hours	**42**

Suggested Text Book(s):

Ian Goodfellow, YoshuaBengio, and Aaron Courville, "Deep Learning", The MIT Press, Cambridge, 2016.

- Charu C. Aggarwal, "Neural Networks and Deep Learning: A Textbook", Springer, 2018.

Suggested Reference Book(s):

- Josh Patterson, Adam Gibson, "Deep Learning: A Practitioner's Approach", 2nd Edition, OReilly Media
- Andrew Ng, "Machine Learning Yearning", available online published by deeplearning.ai

Other useful resources (s):

- http://www.charuaggarwal.net/neural.htm
- https://www.coursera.org/specializations/deep-learning

Evaluation Scheme:

S No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes(2) -10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Introduction to Deep Learning)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	1.8
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	2
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	1.8
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	2.1
CO-5	2	3	3	3	2	1	1	1	2	3	2	2	2.1
Average	2	2.6	2.6	2.6	2.4	1	1	1	2	2.4	1.6	2	

Social Media

COURSE CODE: XXX
COURSE CREDIT: 2
CORE/ELECTIVE: ELECTIVE
L-T-P: 2-0-0
Pre-requisites: Graph Theory, Probability

Course Objectives:

1. Understanding the social media structure.
2. Understanding graph theory, particularly the algebraic description and analysis of graphs and their use in social media studies.
3. Helping scientists, artists, and sociologists understand complex social media phenomena like information diffusion, marketing, and recommendation systems in social media and evolving systems.
4. Acquiring expertise to analyze the social and digital media markets.
5. Providing insight into processing, storing, and visualizing big social media data and social graphs.

Course outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	Understand what constitutes Social and Digital Media	Familiarity
CO-2	Algebraic Graph Analysis	Assessment
CO-3	Design effective and reliable network research projects	Assessment
CO-4	Matrix and Tensor Factorization with Recommender System Applications	Assessment
CO-5	Graph Signal Processing in Social Media	Assessment
CO-6	Big Data Analytics for Social Networks	Assessment

Course Contents:

Unit	Topics	Lectures Required
1	**Graphs in Social and Digital Media** - Dominant social networking/media platforms, Collecting data from social media sites, Social media graphs, Big data issues in social and digital media	3
2	**Mathematical Preliminaries:** Graphs and Matrices & Algebraic Graph Analysis, Matrix decompositions, Applications of graph analysis, Graph clustering, Graph anomaly detection	3
3	**Web Search Based on Ranking** - Information Retrieval, Background, Relevance Beyond the Web Page, Ranking in Heterogeneous Networks	3
4	**Label Propagation and Information Diffusion in Graphs** - Graph construction approaches, Label inference methods,	3

	Diffusion processes, Social network diffusion models	
5	**Graph-Based Pattern Classification and Dimensionality Reduction** - Unsupervised Methods, Supervised Methods, Semi-Supervised Methods	3
6	**Matrix and Tensor Factorization with Recommender System Applications** - Singular Value Decomposition on Matrices for Recommender Systems, Higher Order Singular Value Decomposition (HOSVD) on Tensors A Real Geo-Social System-Based on HOSVD	3
7	**Multimedia Social Search Based on Hypergraph Learning** – Hypergraphs, Game-Theoretic approaches to uniform hypergraph clustering, Spectral clustering for arbitrary hypergraphs	3
8	**Semantic Model Adaptation for Evolving Big Social Data** - Latent Model Adaptation, Parallel and Distributed Approaches for Big Data Analysis, Applications to Evolving Social Data Analysis	3
		28

Suggested Text Book(s):

- Pitas, Ioannis, ed. Graph-based social media analysis. Vol. 39. CRC Press, 2016.

Suggested Reference Book(s):

- Analyzing Social Networks 1st Edition by Stephen P Borgatti, Martin G. Everett, Jeffrey C. Johnson, SAGE Publications Ltd; 1 edition
- Influence and Behavior Analysis in Social Networks and Social MediabyMehmet Kaya, Reda Alhajj, Lecture Notes in Social Networks, Springer International Publishing
- Emerging Research Challenges and Opportunities in Computational Social Network Analysis and Mining by Nitin Agarwal, NimaDokoohaki, Serpil Tokdemir, Lecture Notes in Social Networks, Springer International Publishing

Evaluation Scheme:

S No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 hour.	Syllabus covered upto Test-1
2	T-2	25	1.5 hours	Syllabus covered upto Test-2
3	T-3	35	2 hours	Syllabus covered upto Test-3
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) -10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Avg
CO-1	3	3	3	2	2	3	2	2	2	3	1	3	2.4
CO-2	3	3	3	2	3	2	3	2	2	3	1	3	2.5
CO-3	3	3	3	2	2	3	1	2	3	3	1	3	2.4
CO-4	3	3	3	2	3	3	2	2	3	3	1	3	2.6
CO-5	3	3	3	2	3	3	2	2	3	3	1	3	2.6
CO-6	3	3	3	2	3	3	2	2	1	3	1	3	2.4
Average	3	3	3	2	2.7	2.8	2	2	2.3	3	1	3	

Social Media Lab

COURSE CODE: XXX
COURSE CREDIT: 1
CORE/ELECTIVE: ELECTIVE
L-T-P: 0-0-2
Pre-requisites: Graph Theory, Probability, Statistics
Course Objectives:

1. To create a sustainable software and technical ecosystem driven by a large international open-source community
2. To shares common interests in networks and complex systems
3. To focus on visualization and manipulation, simplicity, and extensibility.
4. To complement the statistical analysis to discover, extract, and classify new patterns in network structure and data.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	To learn about interactive network exploration and visualization accompanied by the graph theory concepts that drive them	Familiarity
CO-2	To understand the nuances of network visualization	Assessment
CO-3	To understand a conceptual, and also an implementation perspective	Assessment
CO-4	Getting Real-world Graph Datasets explores various networks in Gephi	Assessment
CO-5	Exploring Dynamic and Multilevel Graphs focuses on two special kinds of graphs, dynamic graphs, and multilevel graphs	Assessment
CO-6	Exploring Some Useful Gephi Plugins describes several plugins that are extensively used by researchers and developers while working with Gephi	Assessment

List of Experiments:

S No	Topics	Hours
1	**Social Network Analysis Measuring, Mapping, and Modeling Collections of Connections -** The Network Perspective, The Network Analysis Research andPractitioner Landscape, Social Networks in the Era of Abundant Computation, Node-Link Diagrams: Visually MappingSocial Networks	**4**
2	**Getting Started with NodeXL, Layout, Visual Design, and Labeling -** Downloading and Installing NodeXL, Getting Started with NodeXL, Layout: Arranging Vertices in the Graph Pane, Visual Design: Making Network Displays Meaningful	**4**
3	**Calculating and Visualizing Network Metrics -** Kite Network Example, Computing Graph Metrics, Les Misérables Co-Appearance Network	**4**
4	**Preparing Data and Filtering-** Serious Eats Network Example, Filtering to Reduce Clutter and Reveal, Important Features Putting It All	**4**

	Together.	
5	**Clustering and Grouping -** The 2007 Senate Voting Analysis, Les Misérables Character Clusters, Federal Communications Commission (FCC), Lobbying Coalition Network	**4**
6	**Email: The Lifeblood of Modern Communication -** Working with Email Data, leaning email Data in NodeXL, Analyzing Personal Email Networks Creating a Living Org-Chart with an Organizational Email Network	**4**
7	**Twitter** **Conversation, Entertainment, and Information,** **All in One Network!-** The Nuts and Bolts of Twitter, Networks in Twitter Acquiring Data, Discovery with Twitter	**4**
	Total Lab Hours	**28**

Suggested Text Book(s):

- Hansen, D., Shneiderman, B., and Smith, M.A., 2010. Analyzing social media networks with NodeXL: Insights from a connected world. Morgan Kaufmann.Suggested

Reference Book(s):

- Social Analytics: Network and Text Methods with NodeXL and R.1st Edition by Shaila Miranda and Publisher Prospect Press
- Influence and Behavior Analysis in Social Networks and Social MediabyMehmet Kaya, Reda Alhajj, Lecture Notes in Social Networks, Springer International Publishing

Online Resources: -

- **https://www.youtube.com/user/brianbritt87/videos**
- **Marc SmithTutorials: https://www.youtube.com/watch?v=TiTxYSqPBaI&list=PL0FBF4A3DCF40BCE2**

Evaluation Scheme:

S No	Exam	Coverage/Scope of Examination	Marks
1	Mid Term Test	Viva and Written Exam	20
2	End Term Test	Viva and Written Exam	20
3	Lab Records		15
4	Teacher Assessment	(Quality and quantity of experiment performed, learning laboratory skills)	30
5	Attendance and discipline in lab		15
6	Total		100

Course Outcomes (COs) contribution to the Program Outcomes (POs)

Course outcomes	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	3	2	2	3	2	2	2	3	1	3	2.4
CO-2	3	3	3	2	3	2	3	2	2	3	1	3	2.5
CO-3	3	3	3	2	2	3	1	2	3	3	1	3	2.4
CO-4	3	3	3	2	3	3	2	2	3	3	1	3	2.6
CO-5	3	3	3	2	3	3	2	2	3	3	1	3	2.6
CO-6	3	3	3	2	3	3	2	2	1	3	1	3	2.4
Average	3	3	3	2	2.7	2.8	2	2	2.3	3	1	3	

COMPUTER ANIMATION

COURSE CODE: XXX
COURSE CREDITS: 2
CORE/ELECTIVE: ELECTIVE
L-T-P: 2-0-0
Description
This course investigates the theory, algorithms, and techniques for describing and programming motion for animation worlds. Approaches that will be explored include keyframing systems, kinematics, the motion of articulated figures, and procedural and behavioral systems.
Pre-requisite: Computer Graphics, C
Course Objectives: Students will be able

1. To learn the basic of animation
2. To learn the fundamentals of keyframing and interpolation.
3. To understand the working of motion.
4. To understand animating behavior and articulated figures.
5. To learn the basic principles of motion capture and apply them to an animation application.
6. To understand Human figure study through the anatomy

Course Outcomes

S No	Course Outcomes	Level of Attainment
CO-1	Understand the basic of animation	Familiarity
CO-2	Able to learn the fundamentals of keyframing and interpolation.	Assessment
CO-3	Understand the working of motion	Familiarity
CO-4	Demonstrate the skills for animating behavior and articulated figures	Assessment
CO-5	Able to learn the basic principles of motion capture	Assessment
CO-6	To develop animation application and facial recognition	Usage

Course Contents:

Unit	Contents	Lectures Required
1	**Introduction-** Motion perception, Heritage of animation, Animation production, Computer animation production, History of computer animation, **Technical Background-** Spaces and transformations, Orientation representation	**4**
2	**Interpolating Values-** Interpolation, Controlling the motion of a point along a curve, Interpolation of orientations, Working with paths, **Interpolation-Based Animation-** Key-frame systems, Animation	**4**

	languages, Deforming objects, Three-dimensional shape interpolation, Morphing (two-dimensional)	
3	**Kinematic Linkages-** Hierarchical modeling, Forward kinematics, Inverse kinematics, **Motion Capture-** Motion capture technologies, Processing the images, Camera calibration, Three-dimensional position reconstruction, Fitting to the skeleton, Output from motion capture systems, Manipulating motion capture data	**5**
4	**Physically Based Animation**- Basic physic, Spring animation examples, Particle systems, Rigid body simulation, Cloth, Enforcing soft and hard constraints, **Fluids-** Liquids and Gases: Specific fluid models, Computational fluid dynamics	**5**
5	**Modeling and Animating Human Figures**- Overview of virtual human representation, Reaching and grasping, Walking, Coverings, **Facial Animation:** Human face, Facial models, Animating the face, Lip-sync animation	**5**
6	**Behavioral Animation-** Primitive behaviors, Knowledge of Environment, Modeling intelligent behavior, Crowds, **Special Models for Animation-** Implicit surfaces, Plants, Subdivision surfaces	**5**
	Total Lecture Hours	**28**

Text Book

- Computer Animation: Algorithms and Techniques, 3rd Edition, by Rick Parent (Morgan Kauffmann, 2012), ISBN: 0124158420
- **Reference Books**
- Foundations of Physically Based Modeling & Animation by Donald H. House and John C. Keyser CRC Press, 2016, ISBN: 9781482234602
- Physics for Game Developers by David M. Bourg, O'Reilly, 2002, ISBN: 0596000065

Evaluation Scheme:

S No	Exam	Marks	Duration	Coverage/ Scope of Examination
1	T-1	15	1 Hour	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Avg
CO-1	1	1		1	1	1	1	1		1	1		1
CO-2	2	2	2			2		2			2		2
CO-3	3	3	3				3	3					3
CO-4		1	1	1	1			1	1	1	1	1	1
CO-5	3	3		3	3				3	3	3	3	3
CO-6	2		2	2	2	2	2	2	2	2	2	2	2
Avg	2.2	2	2	1.8	1.8	1.7	2	1.8	2	1.8	1.8	2	1.9

COMPUTER ANIMATION LAB

COURSE CODE: XXX
COURSE CREDITS: 1
CORE/ELECTIVE: ELECTIVE
L-T-P: 0-0-2

Description

The students will discover the fundamental principles of animation & exploit these fundamental principles to create convincing character motion.

Course Objectives: Students will be able

1. To learn the basic tool of animation
2. To learn the fundamentals of sketching and drawing.
3. To learn the design of animation character.
4. To develop an animation application

Course Outcomes

S No	Course Outcomes	Level of Attainment
CO-1	Capable to work with basic Animator Drawing Tool	Familiarity
CO-2	Demonstrate the skills for sketching and drawing.	Assessment
CO-3	Capable to develop animation character	Assessment
CO-4	Capable to develop animation application	Usage

List of Experiments

S No	Experiment	Hours
1	**Using Animator's Drawing Tools** The Animation Table (lightbox), Field charts, Line Testing Camera, Peg bar, Punching Machine	**4**
2	**Sketching and Drawing** Drawing for Animation, Exercises and Warm-ups on Pegging Sheet, Quick studies from real life, sequential movement drawing, Caricaturing the action, thumbnails drawing for motion	**8**
3	**Developing an Animation Character** Incorporating various moods and shades of a character Various gestures and facial expressions of the character	**8**
4	**Anatomy and Body Language** Front, side and back view of the character, Anatomy and Body Language of the character Caricaturing the character	**8**
	Total Lab Hours	**28**

Textbook

- The complete animation course by Chris Patmore Pub.-Baron's Educational Series (New York)

Reference book

- Animation Unleashed by Ellen Bessen, Michael Weise Productions Pub.2008 (U.S.A)
- The Animator's Survival Kit by Richard Williams, Arrar Straus & Giroux Pub.(U.S.A)

Evaluation Scheme:

S No	Exam	Coverage/Scope of Examination	Marks
1	Mid Term Test	Viva and Written Exam	20
2	End Term Test	Viva and Written Exam	20
3	Lab Records		15
4	Teacher Assessment	(Quality and quantity of experiment performed, learning laboratory skills)	30
5	Attendance and discipline in lab		15
6	Total		100

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Avg
CO-1	1	1		2	1	3	1	1		2	1		1.4
CO-2	2	1	2			2		2		3	2	1	1.9
CO-3	3	2	3		2		2	3			3		2.6
CO-4		1	2	1	3			1	3	2	1	2	1.8
Avg	2	1.3	2.3	1.5	2	2.5	1.5	1.8	3	2.3	1.8	1.5	2

Course Description of Proficiency Curricula for B. Tech (CSE) and B. Tech (IT).

Statistics and Data Science

COURSE CODE: XXXXXXXX
COURSE CREDITS: 2
CORE/ELECTIVE: ELECTIVE
L-T-P: 2-0-0

Pre-requisite: Basic knowledge of High School Mathematics and reasonable programming experience.

Course Objectives:

1. Understand the Fundamentals of Statistics
2. Understand the Probability for Data Analysis
3. Learn how to work with Different Types of Data
4. Different Types of Distributions
5. Apply Statistical Methods and Hypothesis Testing to Business Problems
6. Understand all the concepts of Statistics for Data Science and Analytics
7. Working of Regression Analysis
8. Implement one way and two way ANOVA
9. Chi-Square Analysis
10. Central Limit Theorem

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	Understand all the concepts of Statistics for Data Science and Analytics	Familiarity
CO-2	Compute the probabilities of events along with an understanding of the random variables, expectation, variance, and distributions.	Usage
CO-3	Identify probability distributions commonly used as foundations for statistical modeling.	Assessment
CO-4	Apply Statistical Methods and Hypothesis Testing to Business Problems	Usage
CO-5	Broaden the knowledge about Random Variables, Joint Distributions, Special Distributions	Assessment
CO-6	To have hands-on skills on Illustrative example for data analysis(Implementation of statistical techniques, data interpretation, Regression Analysis, Covariance, Hypothesis testing and analysis of variance)	Usage

Course Contents:

Unit	Contents	Lectures Required
1	**Introduction:** What is Data Science? - Big Data and Data Science hype – and getting past the hype - Why now? – Datafication - Current landscape of perspectives - Skill sets needed **Probability:** Classical, relative frequency, and axiomatic definitions of probability, addition rule and conditional probability, multiplication rule, total probability, Bayes' Theorem and independence, problems.	4
2	**Random Variables:** Discrete, continuous, and mixed random variables, probability mass, probability density, and cumulative distribution functions, mathematical expectation, moments, probability and moment generating function, median, and quantiles, Markov inequality, Chebyshev's inequality, problems, Function of a random variable, problems.	5
3	**Special Distributions:** Discrete uniform, binomial, geometric, negative binomial, hypergeometric, Poisson, continuous uniform, exponential, gamma, Weibull, Pareto, beta, normal, lognormal, inverse Gaussian, Cauchy, double exponential distributions, reliability and hazard rate, reliability of series and parallel systems, problems.	4
4	**Joint Distributions:** Joint, marginal and conditional distributions, product moments, correlation and regression, independence of random variables, bivariate normal distribution, problems**.**	4
5	**Sampling Distributions:** The Central Limit Theorem, distributions of the sample mean and the sample variance for a normal population, Chi-Square, t and F distributions, problems	5
6	**Testing of Hypotheses:** Null and alternative hypotheses, the critical and 8 acceptance regions, two types of error, power of the test, the most powerful test and Neyman-Pearson Fundamental Lemma, tests for one sample and two sample problems for normal populations, tests for proportions, Chisquare goodness of fit test and its applications, problems.	6
	Total Lecture Hours	28

Suggested Text Book(s):

- An Introduction to Probability and Statistics by V.K. Rohatgi & A.K. Md. E. Saleh, Wiley, (2008), 3rd ed.
- Introduction to Probability and Statistics by J.S. Milton & J.C. Arnold, Boston, London, McGraw-Hill, (2006), 4th ed.
- Data Science and analytics with python by Jesus Rogel-Salazar.

Suggested Reference Book(s):

- Introduction to Probability Theory and Statistical Inference by H.J. Larson, John Wiley & Sons, (2005) 3rd ed.

- Introduction to Probability and Statistics for Engineers and Scientists by S.M. Ross, Elsevier, (2014), 4th ed.
- Python Data Science Handbook by Jake VanderPlas, 2017.

Other useful resource(s):

- https://nptel.ac.in/courses/110/106/110106064/
- https://onlinecourses.nptel.ac.in/noc18_cs28/preview
- https://bit.ly/2GvlBfs
- https://bit.ly/3aONiOo

Evaluation Scheme:

S No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course Outcomes (Statistics and Data Science)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	1.8
CO-2	2	3	3	3	3	1	1	1	2	2	1	1	1.9
CO-3	2	2	2	2	1	1	1	1	2	2	1	2	1.6
CO-4	3	3	3	3	2	1	1	1	2	3	3	2	2.3
CO-5	2	3	3	3	1	1	1	1	2	3	2	2	2
CO-6	2	3	3	3	2	1	1	1	2	3	2	2	2.1
Average	2.2	2.7	2.7	2.7	1.8	1	1	1	2	2.5	1.8	1.8	1.9

Statistics and Data Science Lab

COURSE CODE: XXXXXXXX

COURSE CREDITS: 1

CORE/ELECTIVE: ELECTIVE

L-T-P: 0-0-2

Pre-requisite: Basics of programming in R or Python

Course Objectives:

1. Understand the fundamentals of statistics and apply them in practice
2. To analyze the data using different descriptive measures and present graphically.
3. Compute the probabilities of events along with an understanding of the random variables, expectation, variance and distributions.
4. Understand the estimation of mean and variance and their respective one-sample and k sample hypothesis tests.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO1	Understand basics of Python or R syntax, functions and programming	Familiarity
CO2	Learn the core tools for data science with R or Python	Usage
CO3	Understand and carry out regression analysis	Usage
CO4	Visualize data: plot different types of data & draw insights	Usage
CO5	Hypothesis testing in R or Python	Usage
CO6	Analyze the systems using Laplace transform and Z-transform.	Usage

List of Experiments

S. No.	Description	Hours
1	Introduction to the basics of Python or R syntax, functions, and programming.	**2**
2	Introduction various packages are available for statistical analysis. (e.g. “stats” package in R, Lib/statistics.py package in python)	**2**
3	Implementation of statistical techniques using statistical packages.	**2**
4	Evaluation of Statistical Parameters and data interpretation	**2**
5	Regression Analysis	**2**
6	Covariance Analysis	**2**
7	Hypothesis testing	**2**
8	Analysis of variance	**2**
9	Introduction to Numpy in Python	**2**
10	Data Manipulation with Pandas	**2**
11	Data Visualization with Matplotlib	**2**
12	Introduction to Data Preprocessing	**2**
13	Introduction to Machine Learning Models	**2**

14	Introduction to model cross-validation and model performance analysis	**2**
	Total Lab Hours	**28**

Suggested/Resources:

- Python Data Science Handbook by Jake VanderPlas, 2017.
- Data Science and analytics with python by Jesus Rogel-Salazar.
- Introduction to Probability Theory and Statistical Inference by H.J. Larson, John Wiley & Sons, (2005) 3rd ed.
- https://bit.ly/3aONiOo
- https://bit.ly/2GvlBfs
- https://bit.ly/2uIJuxg

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Project-1	10 Marks
4	Lab Assessment	45 Marks
5	Lab Attendance	5 Marks
	Total	100 marks

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Avg
CO1	3	3	3	3	2	2	1	1	1	1	1	1	1.8
CO2	3	3	3	3	3	1	1	1	1	1	1	3	2
CO3	3	3	2	3	2	3	2	1	1	1	2	1	2
CO4	3	3	3	2	3	2	1	1	1	1	1	1	1.8
CO5	2	2	3	3	3	3	1	1	1	1	1	1	1.8
CO6	2	3	3	3	2	2	2	2	2	2	2	2	2.3
Avg	2.7	2.8	2.8	2.8	2.5	2.2	1.3	1.2	1.2	1.2	1.3	1.5	2

Digital Forensics

COURSE CODE: XXXXXXXX
COURSE CREDITS: 2
CORE/ELECTIVE: ELECTIVE
L-T-P: 2-0-0
Pre-requisite: Cryptography and Security, Computer Networks

Course Objectives:

1. To understand underlying principles and many of the techniques associated with digital forensic practices and cybercrime
2. To explore practical knowledge about ethical hacking Methodology.
3. To learn the importance of evidence handling and storage for various devices
4. To develop an excellent understanding of current cybersecurity issues (Computer Security Incident) and analyzed the ways that exploit insecurities.
5. To investigate attacks, IDS .technical exploits and router attacks and "Trap and Trace" computer networks.
6. To apply digital forensic knowledge to use computer forensic tools and investigation report writing

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	Introduction to Cyber Crime and Ethical Hacking	Familiarity
CO-2	Introduction to Digital Forensics and Digital Evidences	Familiarity
CO-3	Computer Security Incident Response Methodology	Assessment
CO-4	Forensic Duplication and Disk Analysis, and Investigation Data Analysis	Assessment
CO-5	Network Forensics Incidents, Using Routers as Response Tools	Usage
CO-6	Forensic Investigation Report and Forensic Tools	Usage

Course Contents:

Unit	Contents	Lectures Required
1	Introduction of Cybercrime: Types of cybercrime, categories of cybercrime, Computers' roles in crimes, Prevention from Cybercrime, Hackers, Crackers, Phreakers Ethical Hacking: Difference between Hacking and Ethical hacking: Steps of Ethical Hacking, Exploring some tools for ethical hacking: reconnaissance tools, scanning tools	5
2	Digital Forensic, Rules for Digital Forensic The Need for Digital Forensics, Types of Digital Forensics, Ethics in Digital Forensics,	5

	Digital Evidences: Types and characteristics and challenges for Evidence Handling	
3	Introduction to Computer Security Incident Goals of Incident Response, Incident Response Methodology, Formulating Response Strategy, IR Process – Initial Response, Investigation, Remediation, Tracking of Significant, Investigative Information, Reporting Pre Incident Preparation, Incident Detection, and Characterization. Live Data Collection: Live Data Collection on Microsoft Windows Systems: Live Data Collection on Unix-based Systems	**5**
4	Forensic Duplication Forensic Image Formats, Traditional Duplication, Live System Duplication, Forensic Duplication tools Disk and File System Analysis: Media Analysis Concepts, File System Abstraction Model The Sleuth Kit: Installing the Sleuth Kit, Sleuth Kit Tools Partitioning and Disk Layouts: Partition Identification and Recovery, Redundant Array of Inexpensive Disks Special Containers: Virtual Machine Disk Images, Forensic Containers Hashing, Carving: Foremost, Forensic Imaging: Deleted Data, File Slack, Data Analysis, Analysis Methodology Investigating Windows systems, Investigating UNIX systems, Investigating Applications, Web Browsers, Email, Malware Handling: Static and Dynamic Analysis	**5**
5	Technical Exploits and Password Cracking, Introduction to Intrusion Detection systems, Types of IDS Understanding Network intrusion and attacks, Analyzing Network Traffic, Collecting Network-based evidence, Evidence Handling. Investigating Routers, Handling Router Table Manipulation Incidents, Using Routers as Response Tools	**4**
6	Report: Goals of Report, Layout of an Investigative Report, Guidelines for Writing a Report, sample for writing a forensic report. Computer Forensic Tools: need and types of computer forensic tools, tasks performed by computer forensic tools. Study of open-source Tools like SFIT, Autopsy, etc. to acquire, search, analyze and store digital evidence	**4**
	Total Lecture Hours	**28**

Suggested Text Book(s):

- Jason Luttgens, Matthew Pepe, Kevin Mandia, "Incident Response and computer forensics",3rd Edition Tata McGraw Hill, 2014.
- Nilakshi Jain, Dhananjay Kalbande, "Digital Forensic: The fascinating world of Digital Evidences " Wiley India Pvt Ltd 2017.
- Cory Altheide, Harlan Carvey "Digital forensics with open source tools "Syngress Publishing, Inc. 2011.
- Chris McNab, Network Security Assessment, By O'Reilly.

Suggested Reference Book(s):

- Clint P Garrison "Digital Forensics for Network, Internet, and Cloud Computing A forensic evidence guide for moving targets and data , Syngress Publishing, Inc. 2010
- Bill Nelson,Amelia Phillips,Christopher Steuart, "Guide to Computer Forensics and Investigations" . Cengage Learning, 2014
- Debra Littlejohn Shinder Michael Cross "Scene of the Cybercrime: Computer Forensics Handbook", 2nd Edition Syngress Publishing, Inc.2008.
- Marjie T. Britz, Computer Forensics and Cyber Crime, Pearson, Third Edition.

Evaluation Scheme:

S No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	1.8
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	2
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	1.8
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	2.1
CO-5	2	2	2	2	3	1	1	1	2	2	1	2	1.8
CO-6	2	3	3	3	2	1	1	1	2	3	2	2	2.1
Average	2	2.5	2.5	2.5	2.5	1	1	1	2	2.3	1.5	2	1.9

Digital Forensics Lab

COURSE CODE: XXXXXXXX
COURSE CREDITS: 1
CORE/ELECTIVE: ELECTIVE
L-T-P: 0-0-2
Pre-requisite: Cryptography and Security, Computer Networks

Course Objectives:

1. To understand underlying principles and many of the techniques associated with digital forensic practices and cybercrime
2. To explore practical knowledge about ethical hacking Methodology.
3. To learn the importance of evidence handling and storage for various devices
4. To develop an excellent understanding of current cybersecurity issues (Computer Security Incident) and analyzed the ways that exploit insecurities.
5. To investigate attacks, IDS .technical exploits and router attacks and "Trap and Trace" computer networks.
6. To apply digital forensic knowledge to use computer forensic tools and investigation report writing

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	Introduction to Cyber Crime and Ethical Hacking	Familiarity
CO-2	Introduction to Digital Forensics and Digital Evidences	Familiarity
CO-3	Computer Security Incident Response Methodology	Assessment
CO-4	Forensic Duplication and Disk Analysis, and Investigation Data Analysis	Assessment
CO-5	Network Forensics Incidents, Using Routers as Response Tools	Usage
CO-6	Forensic Investigation Report and Forensic Tools	Usage

Course Contents:

Unit	Contents	Hours
1	Use a Web Search Engine, and search for companies specializing in computer forensics. Select three and write a two-to-three paper comparing what each company does.	**2**
2	Search the internet for articles on computer crime prosecutions. Find at least two. Write one or two pages summarizing the two articles and identify the key features of the decisions you find in your search.	**2**
3	Using a search engine, search for various computer forensics tools.	**2**
4	Preparing and processing of investigations. Try to examine and identify the evidence from the drives.	**2**
5	Extracting of files that have been deleted.	**2**
6	Illustrate any data acquisition method and validate it. Use an open-source	**2**

	data acquisition tool.	
7	You're investigating an internal policy violation when you find an e-mail about a serious assault for which a police report needs to be filed. What should you do? Write a two-page paper specifying who in your company you need to talk to first and what evidence must be turned over to police.	**2**
8	Create a file on a USB drive and calculate its hash value using FTK Imager. Change the file and calculate the hash value again to compare the files.	**2**
9	Compare two files created in Microsoft office to determine whether the files are different at the hexadecimal level. Keep a log of what you find.	**2**
10	Illustrate the analysis of forensics data.	**2**
11	Illustrate the validating of forensics data.	**2**
12	Locate and extract (JPEG) files with altered extensions.	**2**
13	Examine an E-mail message.	**2**
14	Investigate an E-mail message.	**2**
	Total Lab Hours	**28**

Suggested Text Book(s):

- "Computer Forensics and Investigations", Nelson, Phillips Enfinger, Steuart, Cengage Learning.

Suggested Reference Book(s):

- Brian Carrier, "File System Forensic Analysis" , Addison Wesley, 2005
- Dan Farmer & Wietse Venema ,"Forensic Discovery", Addison Wesley, 2005
- Eoghan Casey , ―Digital Evidence and Computer Crime ―, Edition 3, Academic Press, 2011
- Chris Pogue, Cory Altheide, Todd Haverkos ,Unix and Linux Forensic Analysis DVD ToolKit, Syngress Inc. , 2008
- Harlan Carvey ,Windows Forensic Analysis DVD Toolkit, Edition 2, Syngress Inc. , 2009
- Harlan Carvey ,Windows Registry Forensics: Advanced Digital Forensic Analysis of the Windows
- Registry , Syngress Inc, Feb 2011
- Eoghan Casey, Handbook of Digital Forensics and Investigation, Academic Press, 2009
- M Sonka, V Hlavac and R Boyle, Image Processing, Analysis and Machine Vision, PWS
- Pratt.W.K., Digital Image Processing, John Wiley and Sons, New York, 1978

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Project-1	10 Marks
4	Lab Assessment	45 Marks
5	Lab Attendance	5 Marks
	Total	100 marks

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	1.8
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	2
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	1.8
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	2.1
CO-5	2	2	2	2	3	1	1	1	2	2	1	2	1.8
CO-6	2	3	3	3	2	1	1	1	2	3	2	2	2.1
Average	2	2.5	2.5	2.5	2.5	1	1	1	2	2.3	1.5	2	1.9

Foundation for Data Science and Visualization

COURSE CODE: XXXXXXXX
COURSE CREDITS: 2
CORE/ELECTIVE: ELECTIVE
L-T-P: 2-0-0

Pre-requisite: Basic knowledge of high school mathematics and reasonable programming experience.

Course Objectives:

- Asking the correct questions and analyzing the raw data.
- Modeling the data using various complex and efficient algorithms.
- Visualizing the data to get a better perspective.
- Understanding the data to make better decisions and find the final result.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	Understanding the basics of data science	Familiarity
CO-2	Using versatile and flexible languages (Python and R programming) for supporting data science	Usage
CO-3	Using data processing for collecting and manipulating the data into the usable and desired form	Usage
CO-4	Using data visualization to easily access the huge amount of data in visuals	Usage
CO-5	Using statistics to collect and analyze the numerical data in a large amount and finding meaningful insights from i	Usage
CO-6	Understanding linear algebra to represent, model, synthesize and summarize the complex data	Usage

Course Contents:

Unit	Contents	Lectures Required
1	**Data Science an Introduction:** Computer Science, Data Science, and Real Science, What is Data Science? Need for Data Science, Data Science Components, Tools for Data Science, Data Science Lifecycle, Applications of Data Science	2

2	**Python and R Programming for Data Science for Data Science:** Introduction to Python Programming (Python Basics, Python Data Structures**,** Python Programming Fundamentals**,** Working with Data in Python**,** Working with NumPy, Pandas, SciPy, and Matplotlib). Introduction to R Programming (R basics, Data structures in R, R Programming fundamentals, Working with Data in R, Stings, and Dates in R, Discover R's packages to do graphics)	**5**
3	**Data Processing:** Data Operations**,** Data cleansing**,** Processing CSV Data**,** Processing JSON Data**,** Processing XLS Data**,** Relational databases**,** NoSQL Databases**,** Date and Time**,** Data Wrangling**,** Data Aggregation**,** Reading HTML Pages**,** Processing Unstructured Data**,** Word tokenization**,** Stemming and Lemmatization	**5**
4	**Statistical Data Analysis:** Measuring Central Tendency**,** Measuring Variance**,** Normal Distribution**,** Binomial Distribution**,** Poisson Distribution**,** Bernoulli Distribution**,** P-Value**,** Correlation**,** Chi-square Test**,** Linear Regression	**5**
5	**Linear Algebra:** Visualizing Matrix Operations **(**Matrix Addition, Matrix Multiplication, Applications of Matrix Multiplication**,** Identity Matrices and Inversion**,** Matrix Inversion and Linear Systems, Matrix Rank) Factoring Matrices **(**Why Factor Feature Matrices, LU Decomposition, and Determinants), Eigenvalues and Eigenvectors **(**Properties of Eigenvalues, Computing Eigenvalues), Eigenvalue Decomposition (Singular Value Decomposition, Principal Components Analysis)	**5**
6	**Data Visualization:** Chart Properties**,** Chart Styling**,** Box Plots**,** Heat Maps**,** Scatter Plots**,** Bubble Charts**,** 3D Charts**,** Time Series**,** Geographical Data**,** Graph Data	**6**
	Total Lecture Hours	**28**

Suggested Text Book(s):

- Data Science from Scratch by Joel Grus
- Data Science for Dummies by Lillian Pierson and Jake Porway
- An Introduction to Statistical Learning by Gareth James, Daniela Witten, et al.

Reference Book(s):

- An Introduction to Probability and Statistics by V.K. Rohatgi & A.K. Md. E. Saleh, Wiley, (2008), 3rd ed.
- Introduction to Probability Theory and Statistical Inference by H.J. Larson, John Wiley & Sons, (2005) 3rd ed.

Other useful resources (s):

- https://nptel.ac.in/courses/110/106/110106064/
- https://onlinecourses.nptel.ac.in/noc18_cs28/preview

Evaluation Scheme:

S No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Foundation for Data Science and Visualization)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	3	2	1	1	1	3	2	2	1	1.8
CO-2	3	3	3	3	3	1	1	2	2	2	1	1	2.1
CO-3	2	2	2	2	1	1	2	2	2	2	1	2	1.8
CO-4	3	3	3	3	2	1	1	3	2	3	3	2	2.4
CO-5	3	2	3	3	1	1	2	1	1	3	2	1	1.9
CO-6	2	2	1	2	2	2	3	2	1	2	3	1	1.9
Average	2.5	2.3	2.3	2.7	1.8	1.2	1.7	1.8	1.8	2.3	2	1.3	2.0

Data Science and Visualization Lab

COURSE CODE: XXX
COURSE CREDITS: 1
CORE/ELECTIVE: ELECTIVE
L-T-P: 0-0-2
Pre-requisite: Python/ R Programming and Machine Learning
Course Objectives:

- Asking the correct questions and analyzing the raw data.
- Modeling the data using various complex and efficient algorithms.
- Visualizing the data to get a better perspective.
- Understanding the data to make better decisions and find the final result.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	Understanding the basics of data science	Familiarity
CO-2	Using versatile and flexible languages (Python and R programming) for supporting data science	Usage
CO-3	Using data processing for collecting and manipulating the data into a usable and desired form	Usage
CO-4	Using statistics to collect and analyze the numerical data in a large amount and finding meaningful insights from i	Usage
CO-5	Understanding linear algebra to represent, model, synthesize and summarize the complex data	Usage
CO-6	Using data visualization to easily access the huge amount of data in visuals	Usage

List of Experiments

S No	Description	Hours
1	• Write a Python/R program to create a vector of a specified type and length. Create a vector of numeric, complex, logical, and character types of length 6. • Write a Python/R program to add two vectors of integer type and length 3. • Write a Python/R program to create a list containing a vector, a matrix, and a list and remove the second element • Write a Python/R program to create a list containing a vector, a matrix, and a list and update the last element.	**2**
2	Write Python/R programs to solve the following tasks in both of them. • Read numbers from a file, and print them out in sorted order. • Read a text file, and count the total number of words. • Read a text file, and count the total number of distinct words. • Read a file of numbers, and plot a frequency histogram of them	**2**
3	**Statistical Data Analysis**	**2**

Write a program to solve linear regression for a given data set.

$Y = ax + b$

where

$a = (n\Sigma xy - \Sigma x\Sigma y) / n\Sigma x^2 - \Sigma(x)^2$

$b = (\Sigma y - a\Sigma x)/n$

Here

Y: response variable

X: predicator variable

a, b: regression coefficients

Read data set

X	Y
-2	-1
1	1
3	2

4

Statistical Data Analysis

Solve the linear regression for a given data set, and also predict sales in the year 2012.

Year	Sales
2005	12
2006	19
2007	29
2008	37
2009	45

2

5

Statistical Data Analysis

Compute Logistic Regression for Organization dataset.

Response Variables

Y = Compensation in rupees

Prediction Variables

X_1 = Experience in years

X_2 = Education in years (after 10th standard)

X_3 = Number of Employees Supervised

X_4 = Number of Projects Handled

S No	Compensation	Experience	Education	Number supervised	Projects
1	1500	2	5	4	10
2	1650	3	6	5	10
3	1750	3	3	5	12
4	1400	2	3	3	9
5	2000	4	4	6	15
6	2200	5	6	6	14
7	2100	1	5	4	12
8	2750	5	8	7	15
9	2900	8	9	8	25
10	1100	3	3	2	7
11	1000	4	2	1	5
12	1350	6	4	4	12
13	1550	4	6	4	11

2

	Here you will get an error as y- value must be $0 < 1$. So modify Y values.	
6	**Statistical Data Analysis** • In an entrance examination, there are twenty multiple-choice questions. Each question has four options, and only one of them is correct. Find the probability of having seven or less than seven correct answers if a student attempts to answer every question at random. • Let us assume that the test scores an entrance exam fit a normal distribution where the mean test score is 67, and the standard deviation is 13.7. Calculate the percentage of students scoring 80 or more in the exam?	**2**
Mid-Semester Lab Examination		**2**
7	**Linear Algebra** Compare the speed of a library function for matrix multiplication to your implementation of the nested loops algorithm. • How much faster is the library on products of random $n \times n$ matrices, as a function of n as n gets large? • What about the product of an $n \times m$ and $m \times n$ matrix, where $n \times m$? • By how much do you improve the performance of your implementation to calculate $C = A \times B$ by first transposing **B** internally, so all dot products are computed along rows of the matrices to improve cache performance?	**2**
8	**Linear Algebra** Implement Gaussian elimination for solving systems of equations, $C \times X = Y$. Compare your implementation against a popular library routine for: • Speed: How does the run time compare, for both dense and sparse coefficient matrices? • Accuracy: What is the size of the numerical residuals $CX - Y$, particularly as the condition number of the matrix increases. • Stability: Does your program crash on a singular matrix? What about almost singular matrices, created by adding a little random noise to a singular matrix?	**2**
9	**Data Visualization** Construct a revealing visualization of some aspect of your favorite data set, using: • A well-designed table. • A dot and/or line plot. • A scatter plot. • A heatmap. • A bar plot or pie chart. • A histogram. • A data map.	**2**
10	**Data Visualization** Create ten different versions of line charts for a particular set of (x, y) points. Which ones are best and which ones worst? Explain why.	**2**
11	**Data Visualization**	**2**

	Construct scatter plots for sets of 10, 100, 1000, and 10,000 points. Experiment with the point size to find the most revealing value for each data set.	
12	**Data Visualization** Experiment with different color scales to construct scatter plots for a particular set of (*x*, *y*, *z*) points, where color is used to represent the z dimension. Which color schemes work best? Which are the worst? Explain why.	**2**
End-Semester Lab Examination		**2**
	Total Lab hours	**28**

Suggested Text Books:

- Python Data Science Hand Book Jake VanderPlas
- Mastering Python for Data Science - by Samir Madhavan.
- R Programming for Data Science by Roger D. Peng

Reference Books:

- Python Data Science: Hands-on Learning for Beginners Kindle Edition by Travis Booth (Author)
- Data Science with R: A Step By Step Guide with Visual Illustrations & Examples by Andrew Oleksy
- R for Data Science: Import, Tidy, Transform, Visualize, and Model Data by Hadley Wickham (Author), Garrett Grolemund

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Project-1	10 Marks
4	Lab Assessment	45 Marks
5	Lab Attendance	5 Marks
	Total	100 marks

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Data Science and Visualization Lab)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	3	2	1	1	1	3	2	2	1	1.8
CO-2	3	3	3	3	3	1	1	2	2	2	1	1	2.1
CO-3	2	2	2	2	1	1	2	2	2	2	1	2	1.8
CO-4	3	3	3	3	2	1	1	3	2	3	3	2	2.4
CO-5	3	2	3	3	1	1	2	1	1	3	2	1	1.9
CO-6	2	2	1	2	2	2	3	2	1	2	3	1	1.9
Average	2.5	2.3	2.3	2.7	1.8	1.2	1.7	1.8	1.8	2.3	2	1.3	2.0

Computational Data Analysis

COURSE CODE: XXXXXXXX
COURSE CREDITS: 2
CORE/ELECTIVE: ELECTIVE
L-T-P: 2-0-0
Pre-requisite: Basics of probability and statistics
Course Objectives:

1. To provide students with the foundational knowledge of topics such as probability and statistics and algorithms to solve data analysis problems arising in practical applications,
2. To enable students to effectively apply computational methods to solve exemplar data analysis problems arising in relevant applications.
3. Have a good understanding of the fundamental issues and challenges of machine learning.
4. Have an understanding of the strengths and weaknesses of many popular machine learning approaches.
5. Be able to design and implement various machine learning algorithms in a range of real-world applications.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	To learn the basic concepts and terminology in statistics used in machine learning	Familiarity
CO-2	To understand the concepts associated with the classification and experimental evaluation of classification algorithms	Familiarity
CO-3	To learn about clustering and unsupervised learning	Assessment
CO-4	To learn about various techniques for selecting relevant features selection.	Assessment
CO-5	To learn about various techniques for enhancing the performance of basic machine learning algorithms.	Usage

Course Contents:

Unit	Contents	Lectures Required
1	Supervised Learning, Discriminative Algorithms: Supervised Learning Concept, Linear Regression, Maximum Likelihood, Normal Equation, Gradient Descent, Stochastic Gradient, SVRG. Linear Classification, Logistic Regression.	**5**
2	Generative Algorithms: Multivariate Normal, Linear Discriminant Analysis, Naive Bayes,	**5**

	Laplacian Smoothing, Multiclass Classification, K-NN Multi-class Fisher Discriminant Analysis, Multinomial Regression Support Vector Machines and Kernel Methods: Intuition, Geometric Margins, Optimal Margin Classifier, Multiclass SVM	
3	Unsupervised Learning: EM Algorithm, DBSCAN, k-means, Hierarchical clustering	**4**
4	Regularization, Model Selection, and Optimization: Cross-Validation, Bayesian Optimization Bayesian Regression, Bayesian Logistic Regression Forward and Backward Regression, Lasso, elastic-net. Proximal Gradient, Prox-SVRG. Coordinate Proximal Gradient, Pathwise Coordinate Descent	**5**
5	Feature Selection: Information Gain, Correlation Coefficient, Chi-square test, PCA	**4**
6	Ensemble Learning: Bagging, Boosting, Stacking, Entropy, Building Tree, Bagging features, Bagging Samples, Random Forest, Adaboost, Gradient Tree Boosting	**5**
	Total Lecture Hours	**28**

Suggested Text Book(s):

- Tom Mitchell, "Machine Learning", McGraw Hill, 1997, ISBN 0070428077
- Introduction to Machine Learning Edition 2, by Ethem Alpaydin.
- T. Hastie, R. Tibshirani, & J. H. Friedman, "The Elements of Statistical Learning: Data Mining, Inference, and Prediction", Springer Verlag, 2001.

Suggested Reference Book(s):

- The Elements of Statistical Learning, 2nd Edition, Hastie, Tibshirani and Friedman.
- Foundations of Machine Learning, Mohri, Rostamizadeh and Talwalker
- Richard o. Duda, Peter E. Hart, and David G. Stork, "Pattern Classification", John Wiley Asia, 2006

Other useful resources (s):

- Link to NPTEL course contents: https://nptel.ac.in/courses/106106139/
- https://nptel.ac.in/courses/110106064/

Evaluation Scheme:

S No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Computational Data Analysis)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	1.8
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	2
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	1.8
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	2.1
CO-5	1	2	2	1	3	2	1	1	1	1	1	1	1.4
Average	1.8	2.4	2.4	2.2	2.6	1.2	1	1	1.8	2	1.4	1.8	1.8

Computational Data Analysis Lab

COURSE CODE: XXXXXXXX
COURSE CREDITS: 1
CORE/ELECTIVE: ELECTIVE
L-T-P: 0-0-2
Pre-requisite: Python Programming Language

Course Objectives:

1. To develop students' skills in software development techniques using one or more high-level programming languages relevant to data analytics.
2. To enable students to effectively apply computational methods to solve exemplar data analysis problems arising in relevant applications.
3. To learn the implementation of classification techniques for any dataset.
4. To conduct experiments for clustering techniques for any dataset.
5. To discuss different classification and clustering algorithms based on the analysis of results obtained from the experimental evaluation.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO1	To learn and implement the basic concepts and terminology in statistics used in machine learning	Usage
CO2	To implement classification and clustering algorithms in python	Usage
CO3	To implement feature selection methods in Python	Usage
CO4	To compare different algorithms based on some common factors	Assessment

List of Experiments

S No	Description	Hours
1	Visualize data using any plotting framework How to upload a dataset How to retrieve rows and data in the dataset How to delete a certain column in the dataset How to display minimum, maximum value of a particular feature How to display certain rows of a dataset	**2**
2	Visualize data using any plotting framework How to display certain rows of a dataset How to insert a new row at a particular index Visualization of the dataset (scatterplot, histogram) To find the sum of null values in each column Extracting certain columns	**2**
3	Implement SVM using different kernel methods like Gaussian Radial Basis Function (RBF), Laplace RBF kernel, ANOVA Radial Basis kernel,	**2**

	Polynomial Kernel.	
4	Implement Naïve Bayes using Bernoulli model and Multinomial model (Laplace smoothing and Log-Transformation).	**2**
5	Implement K-NN and DT	**2**
6	Implement Linear regression and Logistic regression	**2**
7	Implement the following clustering techniques: K-means, *Hierarchical,*	**2**
8	Implement the following clustering techniques: *DBSCAN,* EM Algorithm	**2**
9	Implement various feature selection methods Information Gain Correlation Coefficient	**2**
10	Implement various feature selection methods Chi-square test PCA	**2**
11	Implement the following ensemble techniques: XGBoost, AdaBoost	**2**
12	Implement the following ensemble techniques: Gradient Boosting, Bagging	**4**
	Total Lab hours	**28**

Suggested/Resources:

- Tom Mitchell, "Machine Learning", McGraw Hill, 1997, ISBN 0070428077
- Sebastian Raschka, "Python Machine Learning", Packt Publishing Ltd.
- Andreas C. Müller, Sarah Guido, "Introduction to Machine Learning with Python", O'Reilly Media, Inc.
- Sunila Gollapudi, "Practical Machine Learning", Packt Publishing Ltd
- Wes McKinney, "Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython", O'Reilly Media, Inc.
- Willi Richert, "Building Machine Learning Systems with Python", Packt Publishing Ltd.

Link to topics related to course:

- https://www.python-course.eu/machine_learning.php
- https://www.analyticsvidhya.com/blog/2018/05/24-ultimate-data-science-projects-to-boost-your knowledge-and-skills/
- https://www.datacamp.com/

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Attendance	10 Marks
4	Project	20 Marks
5	Lab Assessment	30 Marks
	Total	**100 marks**

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	Average
CO-1	3	2	2	2	3	1	1	1	1	1	2	2	1.8
CO-2	3	3	3	3	3	2	1	2	2	1	2	3	2.3
CO-3	3	3	2	3	3	2	1	2	2	1	2	3	2.3
CO-4	3	3	3	3	3	2	1	2	2	1	2	3	2.3
Average	3	2.8	2.5	2.8	3	1.8	1	1.8	1.8	1	2	2.8	2.2

Big Data and Hadoop

COURSE CODE: XXXXXXXX
COURSE CREDITS: 2
CORE/ELECTIVE: ELECTIVE
L-T-P: 2-0-0
Pre-requisite: None
Course Objectives:

1. Understand the fundamentals of Concepts in BigData and Hadoop etc
2. Understand the fundamentals of Hadoop etc.
3. Be able to use the HDFS file system, debug and run simple Java programs for HDFS.
4. Be aware of the important topics and principles of software development and write better &more maintainable code
5. Be able to program using advanced Java topics like JDBC, Servlets, and JSP.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	What is big data: introduction to the data lake, why do companies care for big data, why do we out of big data, social media	Familiarity
CO-2	History of Hadoop, the importance of HDFS: Hadoop timeline, why Hadoop, Hadoop 1.x architecture, core components, and job process	Assessment
CO-3	Different phases in Map Reduce: input-output formats in each phase, modeling real-world applications in map-reduce, understanding map-reduce program execution, problems in map-reduce	Assessment
CO-4	Apache Hive, Apache PIG: introduction to Hive meta store, SQL vs Hive, Hive query language, managed and external tables, querying data, introduction to PIG, map-reduce vs PIG, PIG in local mode, PIG in the map-reduce mode	Usage
CO-5	SQOOP: Introduction to SQOOP framework, SQOOP flavors of import, SQOOP flavors of export, SQOOP CLI options	Usage
CO-6	FLUME: Introduction to messaging service, applications of a messaging service, FLUME architecture framework, working of a FLUME agent, understanding FLUME configurations, Hadoop ecosystem labs, importing data from MYSQL and querying it using HIVE, configuring FLUME agent to listen to local log files	Assessment

Course Contents:

Unit	Contents	Lectures Required
1	What is big data: introduction to the data lake, why do companies care for big data, why do we out of big data, social media	4
2	History of Hadoop, the importance of HDFS: Hadoop timeline, why Hadoop, Hadoop 1.x architecture, core components, and job process	4
3	Different phases in Map Reduce: input-output formats in each phase, modeling real-world applications in map-reduce, understanding map-reduce program execution, problems in map-reduce	5
4	Apache Hive, Apache PIG: introduction to Hive meta store, SQL vs Hive, Hive query language, managed and external tables, querying data, introduction to PIG, map-reduce vs PIG, PIG in local mode, PIG in a map-reduce mode	4
5	SQOOP: Introduction to SQOOP framework, SQOOP flavors of import, SQOOP flavors of export, SQOOP CLI options	6
6	FLUME: Introduction to messaging service, applications of a messaging service, FLUME architecture framework, working of a FLUME agent, understanding FLUME configurations, Hadoop ecosystem labs, importing data from MYSQL and querying it using HIVE, configuring FLUME agent to listen to local log files	5
	Total Lecture Hours	**28**

Suggested Text Book(s):

- Big Data and Hadoop, V.K. Jain (https://books.google.co.in/books?id=i6NODQAAQBAJ&printsec=frontcover&redir_esc=y#v=onepage&q&f=false).
- Big Data and Hadoop, MAYANK BHUSHAN**.**

Other useful resources (s):

- https://www.youtube.com/watch?v=1vbXmCrkT3Y

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered up to T-1
2	T-2	25	1.5 Hours	Syllabus covered up to T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Big Data and Hadoop)	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**Average**
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	**1.8**
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	**2**
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	**1.8**
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	**2.1**
CO-5	2	3	1	1	2	3	2	1	2	3	3	2	**2.1**
CO-6	2	3	3	2	1	3	2	2	3	3	2	2	**2.3**
Average	**2**	**2.7**	**2.3**	**2.2**	**2.2**	**1.7**	**1.3**	**1.2**	**2.2**	**2.5**	**1.8**	**2**	**2**

Big Data and Hadoop Lab

COURSE CODE: XXXXXXXX
COURSE CREDITS: 1
CORE/ELECTIVE: ELECTIVE
L-T-P: 0-0-2

Pre-requisites: An understanding in practicalities of big data and Hadoop to any programming language (Preferably, C)

Course Objective

The lab course provides a complete description of the inner working of big data and Hadoop. The main focus is on the design of big data techniques. The course also aims to convey the language specifications, use of file management tasks, and map-reduce behind the design of algorithms. It builds an understanding of various techniques like map-reduce, pig Latin scripts, etc.

Course Outcomes (COs):

S No	Course outcomes	Level of Attainment
CO-1	Perform setting up and Installing Hadoop in various operating modes	Familiarity
CO-2	Implement file management tasks in Hadoop	Familiarity
CO-3	Running a Map-Reduce Paradigm	Computational skills
CO-4	Run Pig then write Pig Latin scripts	Technical skills

List of Experiments

S No	Topic	Hours
1	Implement the following data structures in Java: Linked list, stacks, queues, Set and Map	**2**
2	Perform setting up and Installing Hadoop in its three operating modes: Standalone, Pseudo distributed, Fully distributed Use web-based tools to monitor your Hadoop setup.	**4**
3	Implement the following file management tasks in Hadoop: • Adding files and directories • Retrieving files • Deleting files Hint: A typical Hadoop workflow creates data files (such as log files) elsewhere and copies them into HDFS using one of the above command-line utilities.	**4**

4	Run a basic Word Count Map Reduce program to understand Map Reduce Paradigm	**4**
5	Write a Map Reduce program that mines weather data. Weather sensors collecting data every hour at many locations across the globe gather a large volume of log data, which is a good candidate for analysis with Map Reduce since it is semi-structured and record-oriented	**4**
6	Implement Matrix Multiplication with Hadoop Map Reduce	**2**
7	Install and Run Pig then write Pig Latin scripts to sort, group, join, project, and filter your data	**4**
8	Install and Run Hive then use Hive to create, alter, and drop databases, tables, views, functions, and indexes	**4**
	Total Lab Hours	**28**

Evaluation Scheme

S No	Exam	Coverage/Scope of Examination	Marks
1	Mid Term Test	Viva and Written Exam	20
2	End Term Test	Viva and Written Exam	20
3	Lab Records		15
4	Teacher Assessment	(Quality and quantity of experiment performed, learning laboratory skills)	30
5	Attendance and discipline in lab		15
	Total		**100**

Reference Books:

- Big Data and Hadoop, V.K. Jain
- Big Data and Hadoop, MAYANK BHUSHAN

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	2	2	2	1	3	3	2	1	3	2	1	2.1
CO-2	3	3	2	2	1	3	3	1	3	3	3	1	2.3
CO-3	3	3	2	2	2	2	2	1	2	3	3	2	2.3
CO-4	3	3	3	2	2	2	3	2	2	1	2	2	2.3
CO-5	3	3	2	1	1	3	3	1	3	3	3	1	2.3
Average	3	2.8	2.2	1.8	1.4	2.6	2.8	1.4	2.2	2.6	2.6	1.4	2.2

Computability, Complexity, and Algorithms

COURSE NAME: Computability, Complexity and Algorithms
COURSE CODE: XXXXXXXX
COURSE CREDITS: 3
CORE/ELECTIVE: ELECTIVE
L-T-P: 3-0-0
Pre-requisite: None

Course Objectives:

1. Learn to analyze algorithms for Time and Space Complexity
2. Learn asymptotic notations for performance analysis of algorithms.
3. Learn various computational and complexity of randomized algorithms.
4. Apply important algorithmic design paradigms and methods of analysis.
5. Synthesize efficient mathematical induction and asymptotic notations.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	Introduction of algorithms	Familiarity
CO-2	Demonstrate familiarity with major topics of algorithm analysis.	Assessment
CO-3	Introduction of computability theory.	Assessment
CO-4	Analysis of time complexity of randomized algorithms.	Usage
CO-5	An introduction of probability and randomized algorithms	Usage
CO-6	A brief description of probability, mathematical induction, and asymptotic notations	Assessment

Course Contents:

Unit	Contents	Lectures Required
1	**Introduction to algorithm analysis:** Basic introduction of algorithms, divide and conquer paradigm, Asymptotic notations, Probabilistic and randomized algorithms.	**7**
2	**Advanced algorithm I:** Dynamic programming, Greedy algorithms, and amortized analysis.	**7**
3	**Advanced topics in algorithms II:** Graph algorithm, flow in networks, bipartite matching's.	**6**
4	**Computability Theory:** Turing machines, decidability, mapping reducibility	**6**
5	**Complexity Theory:** Introduction to time complexity, NP and NP-completeness, Approximation algorithms, and derandomization.	**7**
6	**Probabilistic and Randomized Algorithms:** Probabilistic algorithms; Randomizing deterministic algorithms, Monte Carlo and	**6**

	Las Vegas algorithms; Probabilistic numeric Algorithms.	
7	**Supplementary material: Mathematical induction, asymptotic notations, and probability**	**3**
	Total Lecture Hours	**42**

Suggested Text Book(s):

- V. J. Rayward-Smith, *A first course in computability,* McGraw Hill, 1995? An introductory paperback that covers Parts I and III of the course, and some of Part II. More detailed than this course.

- D. Harel, *The Science of Computing,* Addison-Wesley, 1989. A good book for background and motivation, with fair coverage of this course and a great deal more. Some may find the style diffuse. Less detailed than this course

Suggested Reference Book(s):

- Robert Sedgewick, *Algorithms,* Addison-Wesley, 2nd ed., 1988. A practical guide to many useful algorithms and their implementation. A reference for Part II of the course.
- J. Bell, M. Machover, *A course in mathematical logic,* North-Holland, 1977. A good mathematical text, for those who wish to read beyond the course.
- G. Boolos, R. Jeffrey, *Computability and Logic,* Cambridge University Press, 1974

Other useful resources (s):

- youtube.com/playlist?list=PLLkyyG3XCR1mCH_XAWGdm9u4h_VTIRYC-

Evaluation Scheme:

S No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered up to T-1
2	T-2	25	1.5 Hours	Syllabus covered up to T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Computability, Complexity, and Algorithms)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	1.8
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	2
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	1.8
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	2.1
CO-5	2	3	1	1	2	3	2	1	2	3	3	2	2.1
CO-6	2	3	3	2	1	3	2	2	3	3	2	2	2.3
Average	2	2.7	2.3	2.2	2.2	1.7	1.3	1.2	2.2	2.5	1.8	2	2

Course Outcomes (COs) contribution to PSOs

Attainment of PSOs through COs					
Sr. No.	PSO-1	PSO-2	PSO-3	PSO-4	Average
CO-1	3	2	2	1	2
CO-2	3	3	2	2	2.5
CO-3	3	2	3	2	2.5
CO-4	3	3	2	3	2.8
CO-5	3	2	2	1	2
CO-6	3	2	1	2	2
Average Score	3	2.3	2	1.8	

Computability, Complexity and Algorithms Lab

Course Code: XXXXXXX
Course Title: Computability, Complexity and Algorithms Lab
Course Credits: 01
CORE/ELECTIVE: ELECTIVE
Semester: VIIIth Semester
L-T-P: 0-0-2

Pre-requisites: An understanding in practicalities of Computability, Complexity, and Algorithms to any programming language (Preferably, C)

Course Objective
The lab course provides a complete description of the inner working of complexity and algorithms. The main focus is on the design of algorithms and computational techniques. The course also aims to convey the language specifications, use of regular expressions, and computations behind the design of algorithms.
Course Outcome (CO)

S No	Course outcomes	Level of Attainment
CO-1	Construction of dynamic and greedy algorithms	Familiarity
CO-2	Analyzing the *t*ime complexity of graph, dynamic and greedy methods	Familiarity
CO-3	Construction of minimization of automata	Computational skills
CO-4	Building various probabilistic techniques	Technical skills

List of Practical

S. No	Topic	Hours
1	Write a program to read and translate integers into numbers. e.g. 1=ONE, 12 = ONE TWO and 856 = EIGHT FIVE SIX, Generate an error if the number of digits is more than 3	**2**
2	Write a program to convert infix notation to postfix notation.	**2**
3	Implement a DFA which simulates the regular expression a + (aa)*b.	**4**
4	Write a program to implement minimization of finite automata	
5	Implementation of greedy algorithms	**4**
6	Implementation of dynamic programming algorithms	
7	Program for computation of computability and complexity theory.	**4**
8	Write a program to check advanced algorithms like dynamic programming, greedy algorithm.	**4**
9	Implementation of an approximation algorithm	**4**
10	Implementation of a randomized algorithm	**4**
	Total Lab Hours	**28**

Evaluation Scheme

S No	Exam	Coverage/Scope of Examination	Marks
1	Mid Term Test	Viva and Written Exam	20
2	End Term Test	Viva and Written Exam	20
3	Lab Records		15
4	Teacher Assessment	(Quality and quantity of experiment performed, learning laboratory skills)	30
5	Attendance and discipline in lab		15
6	Total		100

Reference Booka

- V. J. Rayward-Smith, *A first course in computability,* McGraw Hill, 1995? An introductory paperback that covers Parts I and III of the course, and some of Part II. More detailed than this course.

- D. Harel, *The Science of Computing,* Addison-Wesley, 1989. A good book for background and motivation, with fair coverage of this course and a great deal more. Some may find the style diffuse. Less detailed than this course

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	2	2	1	2	3	3	2	1	3	2	1	2.1
CO-2	3	3	2	1	1	3	3	1	3	3	3	1	2.3
CO-3	3	3	1	1	2	2	2	1	2	3	3	2	2.1
CO-4	3	3	2	2	2	2	3	2	2	1	2	2	2.2
CO-5	3	3	2	1	1	3	3	1	3	3	3	1	2.3
Average	3	2.8	1.8	1.2	1.6	2.6	2.8	1.4	2.2	2.6	2.6	1.4	2.2

Course Outcomes (COs) contribution to PSOs

Attainment of PSOs through COs					
Sr. No.	PSO-1	PSO-2	PSO-3	PSO-4	Average
CO-1	3	2	2	1	2
CO-2	3	3	2	2	2.5
CO-3	3	2	3	2	2.5
CO-4	3	3	2	3	2.8
CO-5	3	2	2	1	2
CO-6	3	2	1	2	2
Average Score	3	2.3	2	1.8	

Computer and Robot Vision

Course Name: Computer and Robot Vision
Course Code: XXXXX
Course Credits: 3
CORE/ELECTIVE: ELECTIVE
L-T-P: 3-0-0
Pre-requisite: Image Processing and Robotics

Course Objectives:

1. To learn fundamental image processing techniques required for computer vision.
2. To learn shape analysis and boundary tracking.
3. To learn and apply chain codes and other region descriptors.
4. To learn and apply the Hough Transform for line, circle, and ellipse detections.
5. To learn and apply 3D vision techniques, implement motion-related techniques, and Develop applications using computer vision techniques.

Course outcomes:

S No	Course outcomes	Level of Attainment
CO-1	Implement fundamental image processing techniques required for computer vision	Familiarity
CO-2	Perform shape analysis and implement boundary tracking techniques	Usage
CO-3	Apply chain codes and other region descriptors.	Usage
CO-4	Apply Hough Transform for line, circle, and ellipse detections	Usage
CO-5	Apply 3D vision techniques, implement motion-related techniques, and Develop applications using computer vision techniques	Usage

Detailed Course Contents:

Unit	Contents	Lectures required
1	**CAMERAS:** Pinhole Cameras, **Radiometry – Measuring Light:** Light in Space, Light Surfaces, Important Special Cases, **Sources, Shadows, And Shading:** Qualitative Radiometry, Sources, and Their Effects, Local Shading Models, Application: Photometric Stereo, Interreflections: Global Shading Models, **Color:** The Physics of Color, Human Color Perception, Representing Color, A Model for Image Color, Surface Color from Image Color.	**8**
2	**Linear Filters:** Linear Filters and Convolution, Shift Invariant Linear Systems, Spatial Frequency, and Fourier Transforms, Sampling, and Aliasing, Filters as Templates, **Edge Detection:** Noise, Estimating Derivatives, Detecting Edges, **Texture:** Representing Texture, Analysis (and Synthesis) Using Oriented	**8**

	Pyramids, Application: Synthesis by Sampling Local Models, Shape from Texture.	
3	**The Geometry of Multiple Views:** Two Views, **Stereopsis:** Reconstruction, Human Stereposis, Binocular Fusion, Using More Cameras, **Segmentation by Clustering:** What Is Segmentation?, Human Vision: Grouping and Gestalt, Applications: Shot Boundary Detection and Background Subtraction, Image Segmentation by Clustering Pixels, Segmentation by Graph-Theoretic Clustering,	**8**
4	**Segmentation by Fitting a Model:** The Hough Transform, Fitting Lines, Fitting Curves, Fitting as a Probabilistic Inference Problem, Robustness, **Segmentation and Fitting Using Probabilistic Methods:** Missing Data Problems, Fitting, and Segmentation, The EM Algorithm in Practice, **Tracking With Linear Dynamic Models:** Tracking as an Abstract Inference Problem, Linear Dynamic Models, Kalman Filtering, Data Association, Applications, and Examples.	**8**
5	**Geometric Camera Models:** Elements of Analytical Euclidean Geometry, Camera Parameters and the Perspective Projection, Affine Cameras and Affine Projection Equations, **Geometric Camera Calibration:** Least-Squares Parameter Estimation, A Linear Approach to Camera Calibration, Taking Radial Distortion into Account, Analytical Photogrammetry, An Application: Mobile Robot Localization, **Model-Based Vision:** Initial Assumptions, Obtaining Hypotheses by Pose Consistency, Obtaining Hypotheses by pose Clustering, Obtaining Hypotheses Using Invariants, Verification, Application: Registration In Medical Imaging Systems, Curved Surfaces, and Alignment.	**10**
	Total Lecture Hours	**42**

Evaluation Scheme:

S No	Exam	Marks	Duration	Coverage/Scope of Examination
1	Test -1	15	1 hr.	Syllabus covered upto T- 1
2	Test -2	25	1 hr 30 min.	Syllabus covered upto T- 2
3	Test - 3	35	2 hours	Full Syllabus
4	Regularity, Assignments, Quizzes.	25	Entire Semester	Regularity- 4 Assignments - 9 Quizzes - 12

Text Books:

- David A. Forsyth and Jean Ponce: Computer Vision – A Modern Approach, PHI Learning (Indian Edition), 2009.

Reference Books:

- E. R. Davies: Computer and Machine Vision – Theory, Algorithms and Practicalities, Elsevier (Academic Press), 4th edition, 2013.

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

COs	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	3	3	2	3	3	2	3	2	3	3	2.8
CO-2	3	3	3	3	2	3	3	2	3	2	3	3	2.8
CO-3	3	3	3	3	2	3	3	2	3	2	3	3	2.8
CO-4	3	3	3	3	2	3	3	2	3	2	3	3	2.8
CO-5	3	3	3	3	2	3	3	2	3	2	3	3	2.8
CO-6	3	2	2	3	3	3	3	2	3	2	3	3	2.7
Average	3	2.8	2.8	3	2.2	3	3	2	3	2	3	3	2.7

Computer and Robot Vision Lab

Course Name: Computer and Robot Vision Lab
Course Code: xxx
Course Credits: 01
CORE/ELECTIVE: ELECTIVE
L-T-P: 0-0-2
Pre-requisites: Image Processing and Artificial Intelligence

Objective: The main target of computer vision is the 3-D world. Most computer vision algorithms require some form of image processing. Robot vision is to program a **robot** to "see" through a camera either mounted on the **robot**, or in a static position, takes pictures of each workpiece that the **robot** will interact with. This course integrates the two disciplines to achieve a significant purpose.

Course Outcomes (COs)

S No	Course outcomes	Level of Attainment
CO 1	To study cameras, radiometry, sources, and properties.	Familiarity
CO 2	To understand and implement linear filters, edge detection, and texture.	Usage
CO 3	To understand and implement the Geometry of Multiple Views, Stereopsis, and Segmentation by Clustering.	Usage
CO 4	To understand and implement Segmentation by Fitting a Model, Segmentation and Fitting Using Probabilistic Methods, and Tracking With Linear Dynamic Models.	Usage
CO 5	To understand and implement Geometric Camera Models and Geometric Camera Calibration.	Usage

List of experiments

S No	Topic	Hours
1	Pinhole Cameras, Radiometry – Measuring Light, Sources, Shadows, And Shading, Color	6
2	Linear Filters, Edge detection, and Texture	6
3	The Geometry of Multiple Views, Stereopsis, and Segmentation by Clustering	6
4	Segmentation by Fitting a Model, Segmentation and Fitting Using Probabilistic Methods, and Tracking With Linear Dynamic Models	6
5	Geometric Camera Models and Geometric Camera Calibration	4
	Total Lab Hours	**28**

Evaluation Scheme:

S No	Exam	Coverage/Scope of Examination	Marks
1	Mid Term Test	Viva and Written Exam	20
2	End Term Test	Viva and Written Exam	20
3	Lab Records		15
4	Teacher Assessment	(Quality and quantity of experiment performed, learning laboratory skills)	30
5	Attendance and discipline in lab		15
6	Total		100

Text Books:

- David A. Forsyth and Jean Ponce: Computer Vision – A Modern Approach, PHI Learning (Indian Edition), 2009.

Reference Books:

- E. R. Davies: Computer and Machine Vision – Theory, Algorithms and Practicalities, Elsevier (Academic Press), 4th edition, 2013.

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

S No	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	3	2	2	3	1	1	2	1	1	3	2.1
CO-2	3	3	3	3	3	3	1	1	2	1	1	3	2.3
CO-3	3	3	3	3	3	3	1	1	2	1	1	3	2.3
CO-4	3	3	3	3	3	3	1	1	2	1	1	3	2.3
CO-5	3	3	3	3	3	3	1	1	2	1	1	3	2.3
CO-6	3	3	3	3	3	3	1	1	2	1	1	3	2.3
Average	3	3	3	2.8	2.8	3	1	1	2	1	1	3	2.2

Human-Computer Interaction

Course Name: Human-Computer Interaction
Course Code: XXXXX
Course Credits: 2-0-0
CORE/ELECTIVE: ELECTIVE
L-T-P: 3-0-0
Pre-requisite: Image Processing and Robotics

Course Objectives:

- Design, implement, and evaluate effective and usable graphical computer interfaces.
- Describe and apply core theories, models, and methodologies from the field of HCI.
- Describe and discuss current research in the field of HCI.
- Implement simple graphical user interfaces using the Java Swing toolkit.
- Describe special considerations in designing user interfaces for older adults.

Course Outcomes:

S No	Course outcomes	Level of Attainment
CO-1	To learn to explain why it is important to design interactive products that are usable, define key terms used in interaction design	Familiarity
CO-2	To learn to explain key theories used in the design of interactive products and to explain the importance of iteration, evaluation, and prototyping in interaction design	Familiarity
CO-3	To gather data in the context of developing a simple interactive product using suitable techniques	Technical Skills
CO-4	To produce a low-fidelity prototype for an interactive product based upon a simple list of interaction design principles and to evaluate an interactive product using suitable techniques	Technical Skills
CO-5	To communicate effectively to peers and specialists about requirements, design, and evaluation activities relating to interactive products	Key Skills
CO-6	To define a suitable program of user involvement that treats users ethically and fairly.	Key Skills

Course Contents:

:

Unit	Topic	Lectures required
1	Principles of HCI : History and Foundations of HCI, Research Frameworks in HCI, Modeling Social and Emotional Processes, Computer-Mediated Communication, Social and Embodied Interfaces I, II, Computer-Supported	4

	Collaborative Work	
2	Principles of HCI : Speech Interfaces, Games, Crowdsourcing, Information Visualization, Ubiquitous Computing, Assistive and Accessible Interfaces, Future of HCI	7
3	Human Subjects Research Methods: Introduction: Research methods in HCI, Introduction: What are elements of a research project in HCI?, Introduction: How to choose research designs?, Introduction: Methodological fit, Qualitative research: data collection, Qualitative research: data analysis	5
4	Quantitative research: Experimental design principles, Quantitative research: Step-by-step experimental design, Quantitative research: Measurement, Part I, Quantitative research: Measurement, Part II, Quantitative research: Measurement, Part III, Quantitative research: Scale construction, Quantitative research: Statistics, Part I, Quantitative research: Statistics, Part II, Quantitative research: Statistics, Part III	8
5	**Project:** Completing the required human-subjects research training program and an Institutional Review Board (IRB) application for the project, Gaining a theoretical and empirical understanding of the application domain, Applying exploratory and experimental research methods in HCI	2
6	Prototyping user interfaces, Designing exploratory and experimental studies, Gaining experience in recruiting participants, and conducting studies with human subjects, Creating generalizable knowledge on how computing can improve aspects of human life.	2
	Total Lecture Hours	28

Evaluation Scheme

S No	Exam	Marks	Duration	Coverage/Scope of Examination
1	Test -1	15	1 hr.	Syllabus covered up to T- 1
2	Test -2	25	1 hr 30 min.	Syllabus covered up to T- 2
3	Test - 3	35	2 hours	Full Syllabus
4	Regularity, Assignments, Quizzes.	25	Entire Semester	Regularity- 4 Assignments - 9 Quizzes - 12

Reference Books:

- Interaction the BCS Specialist Group on Interaction
- The Usability Professionals' Association (UPA) - founded in the US, with local chapters in the US and other countries
- Mikael Ericsson's listing of research labs and projects worldwide
- Ubiquity - ACM online magazine (general IT topics, but lots relevant to HCI)
- Alan's column and resources on HCI Education in SIGCHI Bulletin
- HCI International has a bi-monthly subscription newsletter partly about the conference,but also carrying general news, events, etc. back issues at their Press Room

- Videos in User-System Interaction - collated by Matthias Rauterberg
- The HCI Bibliography - free-access online bibliographic database on Human-Computer Interaction
- HCI Resource Network - event listings, links, jobs, and subscription-only sections, includes A-Z of HCI topics
- Hans de Graaff's HCI Index
- Craig Marion's Software Design Smorgasbord
- Gary Perlman's Resources in HCI columns from Interactions
- University of Michigan HCI resource links
- The Usability First web site has good collections of resources, particularly for web and accessibility
- Usability First glossary of usability terms
- CHI recently completed theses list
- ComputingCases.org a resource site for teaching ethical issues in computing
- SAP Usability Glossary

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Sr No	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Avg
CO-1	3	2	2	1	2	3	3	2	1	1	1	3	2
CO-2	3	3	3	2	1	1	1	3	2	1	1	3	2
CO-3	3	3	2	3	2	1	1	2	2	1	1	2	1.9
CO-4	3	3	3	3	2	1	1	3	2	1	1	2	2.1
CO-5	3	3	3	3	2	1	1	3	2	1	1	3	2.2
CO-6	3	3	3	3	2	1	1	3	2	1	1	3	2.2
Avg	3	2.8	2.7	2.5	1.8	1.3	1.3	2.7	1.8	1	1	2.7	2.1

Human-Computer Interaction Lab

Course Name: Human-Computer Interaction Lab
Course Code: XXXXX
Course Credits: 1
CORE/ELECTIVE: ELECTIVE
L-T-P: 0-0-2

Pre-requisite: Image Processing and Robotics

Course Objective:
This course provides an introduction to and overview of the field of human-computer interaction (HCI). HCI is an interdisciplinary field that integrates theories and methodologies from computer science, cognitive psychology, design, and many other areas. Course readings will span current theory and practice in interface specification, design and evaluation, as well as current and classic research papers in HCI. Students will work on both individual and team projects to design, implement and evaluate computer interfaces. The course is open to students from all disciplines, providing them with experience working in interdisciplinary design teams.
Lab course of two hours per week will supplement the theory. Implementation of basic and advanced algorithms will be done with C/C++. Basic knowledge of C/C++ programming is mandatory.
The course will involve four hours of contact including lectures, tutorials and lab classes. Students are strongly encouraged to participate actively in class discussions.

Course Outcomes (COs)

S No	Course outcomes	Level of Attainment
CO 1	To design interactive products that are usable, define key terms used in interaction design, explain key theories used in the design of interactive products.	Familiarity
CO 2	To explain the importance of iteration, evaluation, and prototyping in interaction design.	Usage
CO 3	To gather data in the context of developing a simple interactive product using suitable techniques, produce a low-fidelity prototype for an interactive product based upon a simple list of interaction design principles.	Usage
CO 4	To evaluate an interactive product using suitable techniques.	Usage
CO 5	To define a suitable program of user involvement that treats users ethically and fairly.	Usage

List of Experiments

S No	Topics	Hours
1	Getting familiar with Visual Studio Multiplication and Addition of any two numbers	**2**
2	Design an user interface for assigning a grade to students based on the subjects marks Design user interface for printing the numbers in Ascending order Descending order Subtraction	**2**
3	Design an user interface for calculator Design an user interface for registration of a student for admissions.	**2**
4	Design an user interface for semester registration Design an user interface for displaying and changing of a picture on the form Design an user interface for To count the number of digits in a given number	**2**
5	Design an user interface for simple sort program Design user interface	**2**
6	User interest form Making suggestion form	**2**
7	Design an user interface to check whether the year is a leap year or not Design an user interface for menu-based program	**2**
8	Design user Interfaces for ATM Machine Design user Interfaces for Socio E-commerce shop	**2**
9	Design user Interfaces for SmartPhone Design user Interfaces for Railway Reservation System	**4**
10	Design user Interfaces for Online Examination Design user Interfaces for Hospital management	**4**
11	Design user Interfaces for library management Design and User Interfaces for Hotel Booking	**4**
	Total Lab Hours	**28**

Evaluation Scheme:

S No	Exam	Coverage/Scope of Examination	Marks
1	Mid Term Test	Viva and Written Exam	20
2	End Term Test	Viva and Written Exam	20
3	Lab Records		15
4	Teacher Assessment	(Quality and quantity of experiment performed, learning laboratory skills)	30
5	Attendance and discipline in lab		15
6	Total		100

Reference Books:

- Interaction the BCS Specialist Group on Interaction
- The Usability Professionals' Association (UPA) - founded in the US, with local chapters in the US and other countries
- Mikael Ericsson's listing of research labs and projects worldwide
- Ubiquity - ACM online magazine (general IT topics, but lots relevant to HCI)
- Alan's column and resources on HCI Education in SIGCHI Bulletin
- HCI International has a bi-monthly subscription newsletter partly about the conference, but also carrying general news, events, etc. back issues at their Press Room
- Videos in User-System Interaction - collated by Matthias Rauterberg
- The HCI Bibliography - free-access online bibliographic database on Human-Computer Interaction
- HCI Resource Network - event listings, links, jobs, and subscription-only sections, includes A-Z of HCI topics
- Hans de Graaff's HCI Index
- Craig Marion's Software Design Smorgasbord
- Gary Perlman's Resources in HCI columns from Interactions
- University of Michigan HCI resource links
- The Usability First web site has good collections of resources, particularly for web and accessability
- Usability First glossary of usability terms

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

S No	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Avg
CO-1	3	3	3	2	2	3	1	1	2	1	1	3	2.1
CO-2	3	3	3	3	3	3	1	1	2	1	1	3	2.3
CO-3	3	3	3	3	3	3	1	1	2	1	1	3	2.3
CO-4	3	3	3	3	3	3	1	1	2	1	1	3	2.3
CO-5	3	3	3	3	3	3	1	1	2	1	1	3	2.3
CO-6	3	3	3	3	3	3	1	1	2	1	1	3	2.3
Avg	3	3	3	2.8	2.8	3	1	1	2	1	1	3	2.2

Cloud Computing: Concepts, Technology & Architecture

COURSE CODE: XXX
COURSE CREDITS: 2
CORE/ELECTIVE: ELECTIVE
L-T-P: 2-0-0

Pre-requisite: Knowledge of Computer Architecture, Computer Networking, and Distributed Computing.

Course Objectives:

1. To demonstrate an understanding of cloud computing concepts and standards.
2. To understand all enabling technologies of Cloud computing.
3. To discuss issues and challenges about the management of emerging cloud computing technologies and learn approaches to manage them.
4. To demonstrate the practical implementation and usage scenarios of Cloud computing.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	To learn the basic concepts, applications, and terminology of cloud computing.	Familiarity
CO-2	To learn basic concepts of infrastructure management and load balancing.	Familiarity
CO-3	To learn basic concepts of cloud security and metrics for evaluation.	Assessment
CO-4	To understand cloud computing and its role in new distributed computing implementation.	Assessment

Course Contents:

Unit	Contents	Lectures required
1	**Understanding Cloud Computing:** Basic Concepts and terminology, Goals and Benefits Risks and Challenges, Roles and boundaries, Cloud characteristics Cluster Computing, Grid Computing NIST Architecture, Cloud Deployment models Cloud service models	4
2	**Cloud Enabling Technologies:** Virtualization, Types of virtualization, Server Consolidation, virtualization management Web Technology Service-Oriented Architecture Datacenter and Multi-tenancy	4

3	**Cloud Infrastructure Management:** Cloud datacenter design, Workloads and software infrastructure for a datacenter Datacenter hardware, energy and power efficiency in a datacenter Cloud usage monitor, Monitoring agent, Resource agent, Polling Agent	**4**
4	**Cloud Mechanisms:** Automated Scaling Load Balancer SLA Monitor Failover System Multi-Cloud Broker	**5**
5	**Load Management:** Fundamental Cloud Architectures: workload distribution architecture, resource pooling architecture, dynamic scalability architecture, service load balancing architecture, cloud bursting architecture Billing Management System Business cost metrics, cloud usage cost metrics	**6**
6	**Metrics & security:** Cloud service metrics Cloud Security Mobile cloud computing Disaster recovery in cloud computing Case studies	**5**
	Total Lecture Hours	**28**

Suggested Text Book(s):

- Cloud Computing: Concepts, Technology & Architecture, by Zaigham Mahmood, Thomas Erl, Ricardo Puttini, Prentice-Hall, ISBN: 9780133387568.
- Cloud Computing Bible, by Barrie Sosinsky, Barrie Sosinsky.

Suggested Reference Book(s):

- Cloud Computing: A Practical Approach by Anthony T. Velte, Toby J. Velte, and Robert Elsenpeter; Tata McGraw – Hill Edition
- The Datacenter as a Computer – An Introduction to the Design of Warehouse Scale Machines by Luiz Andre Barroso and Urs Holzle; Morgan and Claypool Publishers
- Cloud Computing Explained: Implementation Handbook for Enterprises by John Rhoton
- The Cloud at Your Service by Jothy Rosenburg and Arthur Mateos.

Other useful resources (s):

- Link to NPTEL course contents: https://onlinecourses.nptel.ac.in/noc17_cs23/preview
- Link to topics related to course:
  - **https://www.edx.org/learn/cloud-computing**

- **https://www.udemy.com/introduction-to-cloud-computing/**
- **https://nptel.ac.in/courses/106104019/2**

Evaluation Scheme

S No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Tutorials / Assignments, Quizzes, Attendance	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs):

Course outcomes ((Cloud Computing: Concepts, Technology & Architecture)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	1.8
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	2
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	1.8
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	2.1
Average	2	2.5	2.5	2.5	2.5	1	1	1	2	2.3	1.5	2	1.9

Cloud Computing: Concepts, Technology & Architecture Lab

COURSE CODE: XXXXXXXX
COURSE CREDITS: 1
CORE/ELECTIVE: ELECTIVE
L-T-P: 0-0-2
Pre-requisite: Knowledge of Visualization, Web Service Architecture, Computer Architecture, Computer Networking, and Distributed Computing.

Course Objectives:

- To demonstrate various Visualization Platform.
- To demonstrate an understanding of cloud computing concepts and standards.
- To understand all enabling technologies for Cloud Deployment.
- To demonstrate the practical implementation and usage scenarios of Cloud computing.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO1	To learn the basic concepts, applications, and terminology of cloud computing.	Familiarity
CO2	To learn basic concepts of infrastructure management and load balancing.	Familiarity
CO3	To learn basic concepts of cloud security and metrics for evaluation.	Assessment
CO4	To understand cloud computing and its role in new distributed computing implementation.	Assessment

List of Experiments:

S No	Description	Hours
1	Introduction to Infrastructure as a Service Platforms like EC2 (AWS). Demonstrate the creation of a computing platform.	**2**
2	Demonstrate management and deployment for the IAAS platform by Remote Access platforms (Putty, remote desktop, etc).	**2**
3	Introduction to Visualization and its various types (Hypervisor type0 and type1).	**2**
4	Implementation of Visualization platforms (Sun Virtual Box, VM workstation, Zen, KVM) for Virtual Machine (VM) creation and management.	**4**
5	Implement and Management of various Virtual disk standards and VM imaging formats for Virtual Machine.	4
6	Implementation and installation of a Cloud management platform like	**4**

	open-stack / Eucalyptus etc.	
7	Creating a Warehouse Application in SalesForce.com.	4
8	Implementation and Deployment of a Platform as a Service Platform like Google App engine/ Microsoft azure etc.	**2**
9	Installation and Configuration of Hadoop.	**2**
10	Introduction to Cloud Simulation Platforms Like CloudSim and Green Cloud.	**2**
	Total Lab hours	**28**

Suggested Reference Books:

- Cloud Computing: Concepts, Technology & Architecture, by Zaigham Mahmood, Thomas Erl, Ricardo Puttini, Prentice-Hall, ISBN: 9780133387568.
- Cloud Computing Bible, by Barrie Sosinsky, Barrie Sosinsky.
- Cloud Computing: A Practical Approach by Anthony T. Velte, Toby J. Velte, and Robert Elsenpeter; Tata McGraw – Hill Edition
- The Datacenter as a Computer – An Introduction to the Design of Warehouse Scale Machines by Luiz Andre Barroso and Urs Holzle; Morgan and Claypool Publishers
- Cloud Computing Explained: Implementation Handbook for Enterprises by John Rhoton
- The Cloud at Your Service by Jothy Rosenburg and Arthur Mateos.
- Link to NPTEL course contents: https://onlinecourses.nptel.ac.in/noc17_cs23/preview
- Link to topics related to course:
  a. https://www.edx.org/learn/cloud-computing
  b. https://www.udemy.com/introduction-to-cloud-computing/
  c. https://nptel.ac.in/courses/106104019/2Ev

Evaluation Scheme:

S No	Exam	Coverage/Scope of Examination	Marks
1	Mid Term Test	Viva and Written Exam	20
2	End Term Test	Viva and Written Exam	20
3	Lab Records		15
4	Teacher Assessment	(Quality and quantity of experiment performed, learning laboratory skills)	30
5	Attendance and discipline in lab		15
6	Total		100

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	Average
CO1	3	3	3	3	2	2	1	1	1	1	1	1	1.8
CO2	3	3	3	3	3	1	1	1	1	1	1	3	2
CO3	3	3	2	3	2	3	2	1	1	1	2	1	2
CO4	3	3	3	2	3	2	1	1	1	1	1	1	1.8
Average	3	3	2.8	2.8	2.5	2	1.3	1	1	1	1.3	1.5	1.9

Cloud Computing Security

COURSE CODE: XXXXXXXX
COURSE CREDITS: 3
CORE/ELECTIVE: ELECTIVE
L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

1. Understand some of the major security challenges of cloud computing that act as a hindrance to widespread adoption.
2. Learn about some of the newer techniques that scientists are considering to protect cloud systems, their advantages, and disadvantages.
3. Learn how to critically evaluate security literature.
4. Learn how to formulate and solve a research problem in computer security and be able to present it.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	To understand the use of cloud computing	Familiarity
CO-2	A different technique to secure the cloud	Assessment
CO-3	Different types of attacks on the cloud.	Assessment
CO-4	Identify the known threats, risks, vulnerabilities and privacy issues associated with Cloud-based IT services	Usage

Course Contents:

Unit	Contents	Lectures required
1	Architectural and Technological Influences of Cloud Computing, Cloud deployment models Public, Private, Community and Hybrid models, Software as a Service (SaaS) Platform as a Service (PaaS) Infrastructure as a Service (IaaS), Cloud Computing Roles, Risks and Security Concerns	**4**
2	Guiding Security design principles for Cloud Computing, Secure Isolation, Comprehensive data protection, End-to-end access control, monitoring and auditing, Quick look at CSA, NIST and ENISA guidelines for Cloud Security, Common attack vectors and threats	**6**
3	**Secure Isolation**, Compute, Network and Storage, Common attack vectors and threats, Secure Isolation Strategies, Multitenancy, Virtualization strategies, Inter-tenant network segmentation	**6**

	strategies, Storage isolation strategies	
4	**Data Protection:** Understand the Cloud-based Information Life Cycle, Data protection for Confidentiality and Integrity, Common attack vectors and threats, Encryption, Data Redaction, Tokenization, Obfuscation, PKI and Key Management, Assuring data deletion, data retention, deletion and archiving procedures for tenant data, Data Protection Strategies	**6**
5	**Access Control for Cloud:** Understand the access control requirements for Cloud infrastructure, Common attack vectors and threats, Enforcing Access Control Strategies, Compute, Network and Storage, Authentication and Authorization, Roles-based Access Control, Multi-factor authentication, Host, storage and network access control options, OS Hardening and minimization, securing remote access, Verified and measured boot, Firewalls, IDS, IPS and honeypots	**6**
6	**Monitoring and auditing:** Proactive activity monitoring, Incident Response, Monitoring for unauthorized access, malicious traffic, abuse of system privileges, intrusion detection, events and alerts, Auditing – Record generation, Reporting, and Management, Tamper-proofing audit logs, Quality of Services, Secure Management, User management, Identity management, Security Information, and Event Management	**6**
7	**Identity Management in Cloud:** User Identification, Authentication, and Authorization in Cloud Infrastructure, Be able to understand the concepts of Identity & Access Management, Single Sign-on, Identity Federation, Identity providers and service consumers, The role of Identity provisioning	**4**
8	**Technology Review:** OpenStack Platform, Docker, Amazon Web Services	**4**
	Total Lecture Hours	**42**

Suggested Text Book(s):

- Cloud Computing Security: Foundations and Challenges John R. Vacca
- Cloud Security: A Comprehensive Guide to Secure Cloud Computing Ronald L Krutz, Russell Dean Vines

Suggested Reference Book(s):

- Securing The Cloud: Cloud Computing Security Techniques and Tactics by Vic (J.R.) Winkler

- Cloud Computing Design Patterns by Thomas Erl (Prentice Hall)

Other useful resources (s):

- http://www.cs.colostate.edu/~cs656/

Evaluation Scheme:

S No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered up to T-1
2	T-2	25	1.5 Hours	Syllabus covered up to T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Cloud Computing Security)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	1.8
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	2
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	1.8
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	2.1
Average	2	2.5	2.5	2.5	2.5	1	1	1	2	2.3	1.5	2	1.9

Information Security

COURSE CODE: XXX
COURSE CREDITS: 2
CORE/ELECTIVE: Elective
L-T-P: 2-0-0

Pre-requisite: None

Course Objectives:

1. Investigation of core security technologies and security policies to mitigate risks.
2. Gain an understanding of network perimeter security design principles
3. Gain an understanding of free/ commercial security tools and their applications and develop the security solution for a given application/scenario.
4. Ability to review procedures for installation, troubleshooting, and monitoring of network devices to maintain integrity, confidentiality, and availability of data and devices.
5. Knowledge of the technologies that underpin the deployment and maintenance of a secure network.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	Understand the need for security	Familiarity
CO-2	Analysis of security algorithms	Assessment
CO-3	Demonstrate familiarity with major security algorithms and data structure.	Assessment
CO-4	Apply important security algorithmic design paradigms and methods of analysis.	Usage

Course Contents:

Unit	Contents	Lectures required
1	**Symmetric Encryption** Shift Cipher, Substitution Cipher, Vigen`ere Cipher, A Permutation Cipher Introduction To Symmetric Ciphers, Stream Cipher Basics, The Lorenz Cipher, Linear Feedback Shift Registers, Combining LFSRs, RC4	5
2	Introduction To Block Ciphers, Feistel Ciphers and DES, Rijndael, Modes of Operation Key Management, Secret Key Distribution, Formal Approaches to Protocol Checking Hash Functions, Designing Hash Functions, Message Authentication Codes	5

3	**Public Key Encryption and Signatures** Public Key Cryptography Candidate One-way Functions, RSA, ElGamal Encryption, Rabin Encryption, Paillier Encryption Diffie–Hellman Key Exchange, Digital Signature Schemes, The Use of Hash Functions In Signature Schemes, The Digital Signature Algorithm, Schnorr Signatures, Nyberg–Rueppel Signatures	**5**
4	**Attacks on Public-Key Schemes** Wiener's Attack on RSA, Lattices and Lattice Reduction, Lattice-Based Attacks on RSA, Partial Key Exposure Attacks	**5**
5	**Provable Security:** Security of Signature Algorithms, Security of Encryption Algorithms, Hybrid Ciphers, Signature Schemes, Encryption Algorithms	**4**
6	**Advanced Protocols:** Access Structures, General Secret Sharing, Reed–Solomon Codes, Shamir Secret Sharing, Commitment Schemes, Oblivious Transfer, Showing a Graph Isomorphism in Zero-Knowledge, Zero-Knowledge and NP, Sigma Protocols	**4**
	Total Lecture Hours	**28**

Suggested Text Book(s):

- Cryptography: An Introduction, Nigel Smart
- Cryptography and Network Security: Principles and Practice William Stallings

Suggested Reference Book(s):

- A.J. Menezes, P. van Oorschot, and S.A. Vanstone. The Handbook of Applied Cryptography.

Evaluation Scheme:

S No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered up to T-1
2	T-2	25	1.5 Hours	Syllabus covered up to T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Information Security)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	1.8
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	2
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	1.8
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	2.1
Average	2	2.5	2.5	2.5	2.5	1	1	1	2	2.3	1.5	2	1.9

Information Security Lab

COURSE CODE: XXX
COURSE CREDITS: 1
CORE/ELECTIVE: ELECTIVE
L-T-P: 0-0-2

Pre-requisite: None
Course Objectives:

1. To understand the basic security algorithms
2. To Implement various symmetric cipher
3. To implement various public-key encryption algorithms

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO1	Understand the basic security services e.g. Authentication, Access Control, Confidentiality, Integrity	Familiarity
CO2	Learn standard symmetric encryption algorithms	Assessment
CO3	Learn architecture for public and private key cryptography.	Assessment
CO4	Learn the methods of digital signature and encryption.	Assessment
CO5	Learn key management and how key exchange protocols work.	Uses
CO6	Learn futuristic cryptographic techniques like Elliptic Curve and quantum cryptography	Assessment

List of Experiments

S No	Description	Hours
1	Study of Network Security fundamentals - Ethical Hacking, Social Engineering practices.	**2**
2	Study of System threat attacks - Denial of Services	**2**
3	Study of Sniffing and Spoofing attacks	**2**
4	Study of Techniques uses for Web-Based Password Capturing	**2**
5	Study of Different attacks causes by Virus and Trojans	**2**
6	Study of Anti-Intrusion Technique – Honey pot	**2**
7	Study of Symmetric Encryption Scheme – RC4	**4**
8	Implementation of S-DES algorithm for data encryption	**4**
9	Implementation of Asymmetric Encryption Scheme – RSA.	**4**
10	Study of IP based Authentication	**4**
	Total Lab hours	**28**

Suggested/Resources:

- Atual Kahate, " Cryptography and Network Security", TMH.
- William Stalling, " Cryptography and Network Security", Pearson.

Evaluation Scheme:

S No	Exam	Coverage/Scope of Examination	Marks
1	Mid Term Test	Viva and Written Exam	20
2	End Term Test	Viva and Written Exam	20
3	Lab Records		15
4	Teacher Assessment	(Quality and quantity of experiment performed, learning laboratory skills)	30
5	Attendance and discipline in lab		15
6	Total		100

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Avg
CO1	3	3	3	3	2	2	1	1	1	1	1	1	1.8
CO2	3	3	3	3	3	1	1	1	1	1	1	3	2
CO3	3	3	2	3	2	3	2	1	1	1	2	1	2
CO4	3	3	3	2	3	2	1	1	1	1	1	1	1.8
CO5	2	2	3	3	3	3	1	1	1	1	1	1	1.8
CO6	2	3	3	3	2	2	2	2	2	2	2	2	2.3
Avg	2.7	2.8	2.8	2.8	2.5	2.2	1.3	1.2	1.2	1.2	1.3	1.5	2

Game Development and Design

Course Name: Game Development and Design
Course Code: XXX
Course Credits: 2
CORE/ELECTIVE: ELECTIVE
Prerequisite: Knowledge of programming language (Python, C++,

Course Objective(s): To introduce students to the novel concepts of game development and design with special emphasis on its applications in diverse fields and current research.

Course Outcomes:

S No	Course outcomes	Level of Attainment
CO-1	Game Theory Introduction with Various Theorem	Familiarity
CO-2	Introduction of Nash Equilibrium, Bounded Rationality, Strategic Games, Strictly competitive Games	Assessment
CO-3	Methods to solve the Strategic Games with Matrix 2-person Games, 3-person Games	Assessment
CO-4	Introduction of Matrix Games & Linear Programming methods to solve complex Games	Assessment
CO-5	Design the games using by analyzing the Mixed Strategy Nash Equilibrium	Assessment
CO-6	Analysis of Game complexity by finite repeated & infinite repeated games	Assessment
CO-7	Design the Games with timeliness and restrict the strategies	Assessment
CO-8	Learn the games complexity by NASH FOLK Theorem	Usage
CO-9	Analyze the Game Design with best response & equality of pay-off	Usage

Course Contents:

Unit	Chapters	Lectures Required
1	**Introduction:** Game Theory, The theory of rational choice, Theory of Competitive Equilibrium, steady State and Deductive Interpretations, Bounded Rationality Terminology and Notation Nash Equilibrium- Strategic Games, Nash Equilibrium Examples Existence of a Nash Equilibrium, Strictly Competitive Games, Bayesian Games: Strategic Games with Imperfect Information	**6**
2	**Matrix Two-Person Games**(The Basics, The von Neumann Minimax Theorem, Mixed Strategies, Solving 2 × 2 Games Graphically, Graphical Solution of 2 × m and n × 2 Games, Best Response Strategies	**4**
3	**Solution Methods for Matrix Games:** Solution of Some Special	**5**

	Games, Invertible Matrix Games,Symmetric Games, Matrix Games and Linear Programming, Two-Person Nonzero Sum Games(The Basics, 2 × 2 Bimatrix Games, Best Response, Equality of Payoffs,	
4	**Mixed Strategy Nash Equilibrium** Interpretations of Mixed Strategy Nash Equilibrium Correlated Equilibrium Evolutionary Equilibrium Rationalizability and Iterated Elimination of Dominated Actions-Rationalizability Iterated Elimination of Strictly Dominated Actions, Iterated Elimination of Weakly Dominated Actions	**5**
5	**Repeated Games:** The Basic Idea Infinitely Repeated Games vs.\ Finitely Repeated Games Infinitely Repeated Games: Definitions Strategies as Machines Trigger Strategies: Nash Folk Theorems Punishing for a Limited Length of Time	**6**
6	**Game Examples:** 8 Queen Game, Sudoku Puzzle Game, Chess Board Game	**2**
	Total Lecture Hours	**28**

Text Book(s):

- Games Theory An Introduction second edition by E. N Barron Loyola University Chicago Chicago, Illinois

Reference Book(s):

- An Introduction to Game Theory by Martin J. Osborne
- Introduction to Game Theory by StefTijs Tilburg University Tilburg, Hindustan Book Agency(India)
- Games of Strategy Theory And Application by Melvin Dresher Prentice – Hall, Inc. Englewood Cliffs, N.J.

Evaluation Scheme:

S No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered up to T-1
2	T-2	25	1.5 Hours	Syllabus covered up to T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Tutorials / Assignments, Quizzes, Attendance	25	Entire Semester	Assignment - 9 Quizzes - 12 Attendance - 4

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

S No	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Avg
CO-1	3	2	3	1	2	3	3	2	1	2	2	2	2.2
CO-2	3	3	3	1	2	3	3	3	2	2	2	2	2.4
CO-3	3	3	3	1	2	3	2	3	2	2	3	3	2.5
CO-4	3	3	3	3	2	3	3	2	2	2	3	3	2.7
CO-5	3	3	3	2	2	3	3	3	2	2	3	3	2.7
CO-6	3	3	3	2	2	2	3	2	2	2	2	2	2.3
CO-7	3	3	3	2	2	2	2	2	2	2	3	2	2.3
CO-8	3	3	3	3	2	3	3	2	2	2	3	3	2.7
CO-9	3	3	3	3	2	3	3	3	2	2	3	2	2.7
Avg	3	2.9	3	2	2	2.8	2.8	2.4	1.9	2	2.7	2.4	2.5

Game Development Lab

COURSE CODE: XXX
COURSE CREDITS: 1
CORE/ELECTIVE: ELECTIVE
L-T-P: 0-0-2
Pre-requisite: Introduction to Computer Programming C ,C++, Matlab
Course Objectives:

1. To strengthen their problem-solving ability by applying logic & numerical approach.
2. To strengthen the ability to design and represent solutions to problems using Nash Equilibrium and saddle points.
3. To introduce the 2-Person, N-Person Game, Mixed Strategy, Convex Combination

Course Outcomes:

S.No.	Course outcomes	Level of Attainment
CO-1	To explain how the game is implemented through a matrix representation	Familiarity
CO-2	To analyze and decompose the problem into matrix & propose the various solutions using Nash Equilibrium, Mixed Strategy.	Assessment
CO-3	To design the game for 2-person, N-person e.g. Puzzle Game, Chess Board,8 Queen Game	Assessment

List of Experiments

S.No.	Description	Hours
1	There are 100 bankers lined up in each of 100 rows. Pick the richest banker in each row. Javier is the poorest of those. Pick the poorest banker in each column. Raoul is the richest of those. Who is richer: Javier or Raoul	**2**
2	Implement Mixed Strategy Problem & find out the expected payoff	**2**
3	Implement the Mixed strategy Problem and find the saddle point for finite & infinite user	**2**
4	Consider the game with matrix $\begin{bmatrix} 3 & -2 & 4 & 7 \\ -2 & 8 & 4 & 0 \end{bmatrix}$. Solve the game, find the best response for player1 to the strategy$(\frac{1}{4},\frac{1}{2},\frac{1}{8},\frac{1}{8})$. What is 2nd best response to 1st best response?	**2**
5	Consider the game	**2**

	$\begin{matrix}1 & -3 & -5 & 1\\ 0 & 4 & 4 & -2\\ 0 & 0 & 8 & 3\\ 0 & 0 & 0 & 50\end{matrix}$ Solve this game by finding v(A) and the optimal strategies.	
6	Consider the matrix for two-player $\begin{bmatrix}1{,}0 & 1{,}3 & 3{,}0\\ 0{,}2 & 0{,}1 & 3{,}0\\ 0{,}2 & 2{,}4 & 5{,}3\end{bmatrix}$ Find the Nash Equilibrium	**2**
7	Consider the matrix $\begin{bmatrix}1{,}1 & 3,\mathrm{x} & 2{,}0\\ 2\mathrm{x},3 & 2{,}2 & 3{,}1\\ 2{,}1 & 1,\mathrm{x} & \mathrm{x}^2,4\end{bmatrix}$ Find x so that the game has exactly two pure Nash equilibrium?	**2**
8	Consider the game in which each player has two strategies Wait and Go. The game matrix is $\begin{bmatrix}1{,}1 & 1-€,2\\ 2{,}1-€ & 0{,}0\end{bmatrix}$ Find the correlated equilibria corresponding to the Nash equilibria 0<€<1	**2**
9	Implement the prisoner's dilemma game with matrix	**2**
10	The third column of the matrix $\begin{bmatrix}0 & 8 & 5\\ 8 & 4 & 6\\ 12 & -4 & 3\end{bmatrix}$ is dominated by a convex combination. Reduce the matrix and solve the game.	**2**
11	Use dominance to solve the following game even though it has no inverse $\mathrm{A}=\begin{bmatrix}-4 & 2 & -1\\ -4 & 1 & 4\\ 0 & -1 & 5\end{bmatrix}$	**2**
12	Design the magic Square game. A Game has a matrix in which each row has a row sum that is the same as each of the column sums. For example $\mathrm{A}=\begin{bmatrix}11 & 24 & 7 & 20 & 3\\ 4 & 12 & 25 & 8 & 16\\ 17 & 5 & 13 & 21 & 9\\ 10 & 18 & 1 & 14 & 22\\ 23 & 6 & 19 & 2 & 15\end{bmatrix}$	**2**
13	Design the 9×9 Sudoku puzzle game	**2**
14	Implement the chessboard for 2 users and find the optimal strategy	**2**
	Total Lab Hours	**28**

Evaluation Scheme:

S No	Exam	Coverage/Scope of Examination	Marks
1	Mid Term Test	Viva and Written Exam	20
2	End Term Test	Viva and Written Exam	20
3	Lab Records		15
4	Teacher Assessment	(Quality and quantity of experiment performed, learning laboratory skills)	30
5	Attendance and discipline in lab		15
6	Total		100

Reference Books

- An Introduction to Game Theory by Martin J. Osborne
- Introduction to Game Theory by Stef Tijs Tilburg University Tilburg, Hindustan Book Agency(India)
- Games of Strategy Theory and Application by Melvin Dresher Prentice – Hall, Inc. Englewood Cliffs, N.J.

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

CO/PO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	2	2	2	3	1	1	1	1	1	2	2	1.8
CO-2	3	3	3	3	3	2	1	2	2	1	2	3	2.3
CO-3	3	3	2	3	3	2	1	2	2	1	2	3	2.3
Average	3	2.8	2.5	2.8	3	1.8	1	1.8	1.8	1	2	2.8	

Information Auditing and Risk Management

Course Name: Information Auditing and Risk Management
Course Code: XXXXXX
Course Credits: 3-0-0
CORE/ELECTIVE: ELECTIVE
Prerequisite: NIL

Course Objectives

- Targets project leaders involved in managing risk in capital projects.
- Providing a robust introduction of Enterprise Risk Management (ERM) and the ISO 31000 risk management standard.
- Exploring the practical processes involved in identifying, and evaluating internal and external risks to an organization.

Course Outcomes:

S No	Course outcomes	Level of Attainment
CO-1	To learn to explain why it is important to design interactive products that are usable, define key terms used in interaction design	Familiarity
CO-2	To learn to explain key theories used in the design of interactive products and to explain the importance of iteration, evaluation, and prototyping in interaction design	Familiarity
CO-3	To gather data in the context of developing a simple interactive product using suitable techniques	Assessment
CO-4	To produce a low-fidelity prototype for an interactive product based upon a simple list of interaction design principles and to evaluate an interactive product using suitable techniques	Assessment
CO-5	To communicate effectively to peers and specialists about requirements, design, and evaluation activities relating to interactive products	Usage
CO-6	To define a suitable program of user involvement that treats users ethically and fairly.	Usage

Course Contents:

Unit	Topic	Lectures Required
1	Introduction: Overview of course objectives and agenda, Interactive exercise – participants will complete a survey on the level of maturity of project risk management in their organization. Introduction to the Construction Industry Institute's Risk Management best practice area and its role in improving project performance	**4**
2	Risk Management Process: Introduction to risk management Owner and contractor perspectives on risk, The risk management process, Applying	**8**

	risk management throughout the project lifecycle, Roles and responsibilities	
3	Risk Identification: Major sources of risk, Risk identification methods – brainstorming, structured interviews, documentation review and risk checklists	**6**
4	Supporting tools: Risk Register template, Risk Breakdown Structure(RBS), Construction-focused Risk Checklist, Using the Risk Register template to document identified risks	**10**
5	Risk Assessment: The assessment process for identified risks, Selecting an appropriate risk assessment level for each project, Level 1 – Risk Identification, Level 2 – Probability & Impact	**4**
6	Utilizing the **Risk Assessment tables**, Recording assessment results in the Risk Register	**5**
7	Risk Response: Developing risk response plans and actions, Risk response strategies, Examples of "actionable" risk responses, Project contingency	**3**
8	Risk Monitoring: Tracking and reporting risks using the Risk Register, Monitoring existing risks and execution of risk response plans and actions, Integrating risk status into regular project communications and reporting	**2**
	Total Lecture Hours	**42**

Reference Books

- Risk Management, The Blackford Centre.
- Fundamentals of Risk Management: Understanding, Evaluating and Implementing Effective Risk Management
- Operational Risk Management: Best Practices in the Financial Services Industry

Evaluation Scheme:

S No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

CO/PO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	3	1	2	3	3	2	1	1	1	3	2.2
CO-2	3	2	1	2	1	1	2	3	2	1	1	3	1.8
CO-3	3	3	3	3	2	1	2	2	2	1	1	2	2.1
CO-4	3	3	2	3	2	1	2	3	2	1	1	2	2.1
CO-5	3	3	3	3	2	1	2	3	2	1	1	3	2.3
CO-6	3	3	3	3	2	1	2	3	2	1	1	3	2.3
Average	3	2.8	2.5	2.5	1.8	1.3	2.2	2.7	1.8	1	1	2.7	2.1

Information Modeling

COURSE CODE: XXX
COURSE CREDITS: 3
CORE/ELECTIVE: ELECTIVE
L-T-P: 3-0-0
Pre-requisite: Database systems, Data Mining
Course Objectives:

1. Learn to build an information modeling.
2. Learn the Concept of data and process modeling.
3. Learn the Concept of Component modeling.
4. Apply information modeling techniques to solve real-life problems.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	Understand the basics of information modeling application and their usages in different areas	Familiarity
CO-2	To be familiar with the basics of various modeling techniques	Familiarity
CO-3	Ability to apply modeling techniques on real-life scenarios to solve them easily	Assessment
CO-4	Ability to apply information modeling with Linked data	Usage

Course Contents:

Unit	Contents	Lectures Required
1	**Information Model:** Introduction, needs; Components of the information model. **Information Modeling:** Introduction: Why? What? How? Goals; Concepts; Information Modeling Vs Data Modeling.	**8**
2	**Data Modeling:** Introduction; Workflow of Data Modeling; Data Modeling Notations and Languages; Data Modeling Concepts; Challenges in Data Modeling.	**6**
3	**Meta Modeling:** Introduction; Concepts; Requirements on Metamodeling Notations; IRDS - Information Resource Dictionary Standard; Repositories; Introduction to Ontology; Analyzing and Comparing Ontologies with Meta-Models.	**7**
4	**Process Modeling:** Introduction; Workflow Management; Process Modeling; Workflow Management System; Executing Processes; Information Delivery Manuals and Model View Definitions.	**6**

5	**Data, Ontology, and Component Modelling:** A Taxonomic Class Modelling Methodology for Object-Oriented Analysis; Comprehension of Hierarchical ER Diagrams Compared to Flat ER Diagrams; Constraints on Conceptual Join Paths; A Service-Oriented Component Modelling Approach; Evaluation of Component-Based Development Methods.	**7**
6	**Information Modelling and Linked Data:** Introduction; Concepts of Linked Data and the Semantic Web; Technology: The Semantic Web Stack; Multiple Interlinked Models; Dynamic, Semantic Model Extensions; Querying and Reasoning	**8**
	Total Lecture Hours	**42**

Suggested Text Book(s):

- John Krogstie (SINTEF, Norway), Terry Halpin (Neumont University, USA), and Keng Siau (Missouri University of Science and Technology, USA): Information Modeling Methods and Methodologies: Advanced Topics in Database Research, IGI-Global, August 2004.
- André Borrmann, Markus K¨onig, Christian Koch, Jakob Beetz: Building Information Modeling, Springer,

Suggested Reference Book(s):

- Charrel, Pierre-Jean; Jaakkola, Hannu; Kangassalo, Hannu; Kawaguchi, Eiji: Information Modelling and Knowledge Bases, Frontiers in artificial intelligence and applications,

Evaluation Scheme:

S No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered up to T-1
2	T-2	25	1.5 Hours	Syllabus covered up to T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	1	1	1	2	1	1	1	1	1	2	3	1.4
CO-2	3	1	1	2	2	1	1	1	1	1	2	3	1.6
CO-3	2	2	2	3	3	2	1	1	2	1	3	3	2.1
CO-4	3	2	3	3	3	2	1	1	1	1	3	3	2.2
Average	2.5	1.5	1.8	2.3	2.5	1.5	1	1	1.3	1	2.5	3	1.8

Ethics and Information Technology

COURSE CODE: XXX
COURSE CREDITS: 3
CORE/ELECTIVE: ELECTIVE
L-T-P: 3-0-0
Pre-requisite: None
Course Objectives:

1. The course will discuss the social impacts of computers in information technology.
2. Students will be given a broad overview of relevant topics to include free speech, privacy, security and the law
3. Understand the importance of ethical issues that emerge from the widespread use of information technology.
4. Professional and ethical responsibilities based on community values and the law will be discussed.
5. This course will focus on the economic, social, cultural, and global impacts of decisions that are made relating to information technology.
6. Understand the ethical issues associated with confidentiality and privacy as they relate to information technology.
7. Students will become familiar with organizations, laws, and regulations related to computer ethics and individual conduct in cyberspace.
8. Students will apply critical thinking skills to evaluate cyber ethics issues.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	Demonstrate knowledge of current models of information and computer ethics.	Familiarity
CO-2	Apply ethical theories to interpret personal and group behavior when using a variety of information technology tools.	Assessment
CO-3	Evaluate the nature of ethical choices made by self and others when serving various roles that expose social and multicultural differences.	Assessment
CO-4	Construct written arguments in a variety of formats on the evolving nature of ethical norms relating to new technologies	Usage

Course Contents:

Unit	Contents	Lectures required
1	**Introduction:** Defining key terms: Cyber ethics and Cyber technology, Four Developmental Phases in Cyber technology, Are Cyber ethics Issues Unique Ethical Issues? Digital Piracy, Cyber ethics as a Branch of	**5**

	Applied Ethics: Three Distinct Perspectives, A Comprehensive Strategy for Approaching Cyber ethics Issues, Ethics, and Morality.	
2	**Ethical Concepts and Critical Thinking:** Discussion of various scenarios: The "Runaway Trolley": A Classic Moral Dilemma, A Controversial Policy in America, A Dilemma Involving Conflicting Duties, Character-Based Ethical Theories, Integrating Aspects of Classical Ethical Theories into a Single Comprehensive Theory, Constructing an Argument: Valid Arguments, Sound Arguments, Invalid Arguments, Inductive Arguments, Fallacious Arguments, A Seven-Step Strategy for Evaluating arguments, Identifying some common fallacies.	**6**
3	**Professional Ethics and Privacy:** Professional Ethics, Safety-Critical Software, Professional Codes of Ethics and Codes of Conduct, Conflicts of Professional Responsibility: Employee Loyalty and Whistle-Blowing, Moral, Responsibility, Legal Liability, and Accountability, Risk Assessment in the Software Development Process, Do Some Computer Corporations Have Special Moral Obligations? **Privacy:** Personal privacy, Importance of Privacy, Gathering Personal Data: Monitoring, Recording, and Tracking Techniques Exchanging Personal Data: Merging and Matching Electronic Records, Mining Personal Data, Protecting Personal Privacy in Public Space, Privacy-Enhancing Technologies, Privacy Legislation, and Industry Self-Regulation.	**6**
4	**Security in Cyberspace:** Security in the context of cyber technology, Three categories of cybersecurity, Hacking, and "The Hacker Ethic, Cyberterrorism, Information Warfare(IW), Cybersecurity and Risk Analysis.	**5**
5	**Cyber Crime:** Cybercrimes and Cybercriminals, Hacking, Cracking, and Counterhacking, Defining Cybercrime, Three Categories of Cybercrime: Piracy, Trespass, and Vandalism in Cyberspace, Cyber-Related Crimes, Technologies and Tools for Combating Cybercrime, National and International Laws to Combat Cybercrime. Various scenarios: Virtual Casino, Prosecuting a Computer Corporation in Multiple Countries, The Pirate Bay Web Site, Are WikiLeaks' Practices Criminal? **Intellectual property:** What is Intellectual Property?Copyright law and Digital Media, Patents, Trademarks, and Trade Secrets, Jurisdictional Issues Involving Intellectual Property Law, Philosophical Foundations for Intellectual Property Rights, The Free Software and the Open Source Movements,	**8**
6	**Regulating Commerce:** Background Issues and Some Preliminary Distinctions, Four Modes of Regulation: The Lessing Model, Digital Rights Management and the Privatization of Information Policy, The Use and Misuse of (HTML) Metatags and Web Hyperlinks, Email-Spam, Free Speech vs. Censorship and Content Control in Cyberspace, "Network Neutrality" and the Future of Internet Regulation. algorithms.	**6**

7	**Community in CyberSpace:** Online Communities and Social Networking Services, Virtual Environments and Virtual Reality, Cyber Identities and Cyber Selves, AI, and its implications.	**4**
8	**Ethical aspects of emerging technologies:** Converging Technologies and Technological Convergence, Bioinformatics and Computational Genomics, Nanotechnology and Nano Computing, Autonomous Machines and Machine Ethics, A "Dynamic" Ethical Framework for Guiding Research in New and Emerging Technologies.	**2**
	Total Lecture Hours	**42**

Suggested Text Book(s):

- Tavani, H.T. (2010). Ethics and technology: Controversies, questions, and strategies in ethical computing (3rd ed.) Massachusetts, John Wiley & Sons Inc. [ISBN: 978-0-470-50950-0].

Suggested Reference Book(s):

- Blackley, J. A., Peltier, J., & Peltier, T. (2003) Information Security Fundamentals, 1st ed. Boca Raton, FL. Auerbach Publications. [ISBN: 0849319579/9780849319570].

Evaluation Scheme:

S No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered up to T-1
2	T-2	25	1.5 Hours	Syllabus covered up to T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Ethics and Information Technology)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	**1.8**
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	**2**
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	**1.8**
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	**2.1**
Average	**2**	**2.5**	**2.5**	**2.5**	**2.5**	**1**	**1**	**1**	**2**	**2.3**	**1.5**	**2**	

Knowledge-Based AI: Cognitive Systems

COURSE CODE: XXX
COURSE CREDITS: 3
CORE/ELECTIVE: ELECTIVE
L-T-P: 3-0-0
Pre-requisite: Discrete Mathematics, Programming Languages

Course Objectives:
The course aims to familiarize the students with the basic concepts as well as with the state-of-the-art research literature in knowledge-based artificial intelligence. After successful completion of this course, students will be able to:

1. Understand concepts, methods, and prominent issues in knowledge-based artificial intelligence
2. Learn specific skills and abilities needed to apply those concepts to the design of knowledge-based AI agents
3. Understand the relationship between knowledge-based artificial intelligence and the study of human cognition.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	Understanding the basic concepts of knowledge-based AI & Cognitive Systems	Familiarity
CO-2	Understanding various fundamental concepts & techniques related to AI as well as cognitive systems.	Familiarity
CO-3	Learning & implementing various reasoning methods such as common sense reasoning, analogical reasoning, etc	Usage
CO-4	Designing & creating as well as metacognition knowledge	Assessment

Course Contents:

Unit	Contents	Lectures Required
1	**Introduction:** Introduction to KBAI & Cognitive Systems, Where Knowledge-Based AI fits into AI as a whole - Cognitive systems: what are they? - AI and cognition: how are they connected?	**5**
2	**Fundamentals:** Semantic Networks - Generate & Test - Means-Ends Analysis - Problem Reduction - Production Systems	**5**
3	**Common Sense Reasoning**: Frames - Understanding - Common Sense Reasoning - Scripts	**4**
4	**Planning & Learning:** Logic, Planning, Learning by Recording Cases - Incremental Concept Learning - Classification - Version	**6**

	Spaces & Discrimination Trees	
5	**Analogical Reasoning:** Case-Based Reasoning - Explanation-Based Learning - Analogical Reasoning	**5**
6	**Visuospatial Reasoning:** Constraint Propagation - Visuospatial Reasoning	**5**
7	**Design & Creativity:** Configuration - Diagnosis - Design - Creativity	**6**
8	**Metacognition:** Learning by Correcting Mistakes - Meta-Reasoning - AI Ethics	**6**
	Total Lecture Hours	**42**

Suggested Text Book(s):

- "Artificial Intelligence: A Modern Approach", Stuart Russell and Peter Norvig, 3rd Edition
- "Artificial Cognitive Systems: A Primer", David Vernon, 1st Edition

Suggested Reference Book(s):

- "Artificial Intelligence by Example", Denis Rothman

Other useful resources (s):

1. Link to NPTEL course contents:
   - https://nptel.ac.in/courses/106/105/106105077/
2. Link to topics related to course:
   - https://www.youtube.com/watch?v=0Alhb1HDsNw
   - https://www.youtube.com/watch?v=JMUxmLyrhSk
   - https://www.udacity.com/course/knowledge-based-ai-cognitive-systems--ud409

Evaluation Scheme:

S No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered up to T-1
2	T-2	25	1.5 Hours	Syllabus covered up to T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Program Outcomes (POs)

Course outcomes (Knowledge-Based AI: Cognitive Systems)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	1.8
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	2
CO-3	2	2	3	3	3	1	1	1	2	2	1	2	1.9
CO-4	2	3	3	3	2	1	1	1	2	3	1	2	2
Average	2	2.5	2.8	2.8	2.5	1	1	1	2	2.3	1.3	2	1.9

Reinforcement Learning

COURSE CODE: XXX
COURSE CREDITS: 3
CORE/ELECTIVE: ELECTIVE
L-T-P: 3-0-0
Pre-requisite: Probability & Statistics, Machine Learning

Course Objectives:
The course aims to familiarize the students with the basic concepts as well as with the state-of-the-art research literature in deep reinforcement learning. After successful completion of this course, students will be able to:

1. Structure of a reinforcement learning problem
2. Understand and apply basic RL algorithms for simple sequential decision-making problems in uncertain conditions.
3. Evaluate the performance of the solution
4. Interpret state-of-the-art RL research and communicate their results.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	Understanding the basic concepts of Reinforcement Learning	Familiarity
CO-2	Understanding Probability Primer Techniques in detail.	Familiarity
CO-3	Learning & implementing various methods & techniques such as TD methods, Monte Carlo, Markov Decision Process, etc.	Usage
CO-4	Learning & understanding policy gradients along with its advantages and disadvantages.	Assessment

Course Contents:

Unit	Contents	Lectures Required
1	**Introduction:** Origin and history of Reinforcement Learning research. Its connections with other related fields and with different branches of machine learning.	**2**
2	**Probability Primer:** Axioms of probability, concepts of random variables, PMF, PDFs, CDFs, Expectation. Concepts of joint and multiple random variables, joint, conditional and marginal distributions. Correlation and independence.	**4**
3	**Markov Decision Process:** Introduction to RL terminology, Markov property, Markov chains, Markov reward process (MRP). Introduction to and proof of Bellman equations for MRPs along with proof of existence of solution to Bellman equations in MRP. Introduction to Markov decision	**6**

	process (MDP), state and action value functions, Bellman expectation equations, optimality of value functions and policies, Bellman optimality equations.	
4	**Prediction & Control by Dynamic Programming:** Overview of dynamic programming for MDP, definition and formulation of planning in MDPs, principle of optimality, iterative policy evaluation, policy iteration, value iteration, Banach fixed point theorem, proof of contraction mapping property of Bellman expectation and optimality operators, proof of convergence of policy evaluation and value iteration algorithms, DP extensions.	**6**
5	**Monte Carlo methods for Model Free Prediction & Control :** Overview of Monte Carlo methods for model free RL, First visit and every visit Monte Carlo, Monte Carlo control, On policy and off policy learning, Importance sampling.	**6**
6	**TD Methods:** Incremental Monte Carlo Methods for Model Free Prediction, Overview TD(0), TD(1) and TD(λ), k-step estimators, unified view of DP, MC and TD evaluation methods, TD Control methods - SARSA, Q-Learning and their variants.	**6**
7	**Function Approximation Methods:** Getting started with the function approximation methods, Revisiting risk minimization, gradient descent from Machine Learning, Gradient MC and Semi-gradient TD(0) algorithms, Eligibility trace for function approximation, After states, Control with function approximation, Least squares, Experience replay in deep Q-Networks.	**6**
8	**Policy Gradients:** Getting started with policy gradient methods, Log-derivative trick, Naive REINFORCE algorithm, bias and variance in Reinforcement Learning, Reducing variance in policy gradient estimates, baselines, advantage function, actor-critic methods.	**6**
	Total Lecture Hours	**42**

Suggested Text Book(s):

- "Reinforcement Learning: An Introduction", Richard S. Sutton and Andrew G. Barto, 2nd Edition
- "Probability, Statistics, and Random Processes for Electrical Engineering", 3rd Edition, Alberto Leon-Garcia

Suggested Reference Book(s):

- "Machine Learning: A Probabilistic Perspective", Kevin P. Murphy

Other useful resources (s):

1. Link to NPTEL course contents:
   - https://nptel.ac.in/courses/106/106/106106143/
2. Link to topics related to course:

- https://www.youtube.com/watch?v=JgvyzIkgxF0
- https://www.youtube.com/watch?v=LzaWrmKL1Z4

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered up to T-1
2	T-2	25	1.5 Hours	Syllabus covered up to T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Program Outcomes (POs)

Course outcomes (Reinforcement Learning)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	2	2	2	2	1	2	1.8
CO-2	2	3	3	3	3	1	3	2	2	2	1	2	2.3
CO-3	2	3	3	3	3	2	3	2	2	2	1	2	2.3
CO-4	2	3	3	3	2	1	2	3	2	3	2	2	2.3
Average	2	2.8	2.8	2.8	2.5	1.3	2.5	2.3	2	2.3	1.3	2	2.2

Architecting Distributed Cloud Applications

COURSE CODE: XXX
COURSE CREDITS: 2
CORE/ELECTIVE: ELECTIVE
L-T-P: 2-0-0
Pre-requisite: Cloud Computing, Distributed applications, Basic networking concepts.
Course Objectives:

1. To understand cloud distributed applications.
2. To know the benefits and challenges of microservices architecture.
3. To learn the fundamentals of service endpoints, scalability, and availability.
4. To know the fundamentals of messaging with queues.
5. To understand best practices for managing service configuration.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	Introduction to cloud computing and distributed cloud applications	Familiarity
CO-2	Network Communication in distributed cloud applications	Assessment
CO-3	Message Communication in distributed cloud applications	Assessment
CO-4	Versioning, upgrading, and configuration of distributed cloud applications	Usage

Course Contents:

Unit	Contents	Lectures Required
1	**Module 1:** **Cloud Computing Introduction:** Cloud computing definition, benefits of cloud computing. What are cloud applications, why develop cloud applications, what are orchestrators and containers in the cloud, the difference between orchestrators and containers? What are micro-services, why convert monolith applications to micro-services, micro-service architectural myths, auto-scaling of cloud microservices?	5
2	**Module 2: Network Communication** Network issues for distributed cloud applications, service endpoint scalability, and availability, forward and reverse proxies, cluster DNS, reverse proxy load balancers. What are service APIs for distributed cloud applications? Fault-tolerant network communication, circuit breaking.	4
3	**Module 3:Messiging Communication** What is message communication, benefits of message communication,	4

	messing with queues, fault-tolerant messaging process, some queue features?	
4	**Module 4: Versioning, upgrading, and configuration** Service update options, rolling updates feature, shutting down a service, gracefully shutting down a service, service configuration, and reconfiguration.	**4**
5	**Module 5: Leader Election** What is leader election, why we need leader, main roles, and responsibilities of a leader, leader election via lease, leader election via queue messages?	**5**
6	**Module 6: Storage Services** Introduction to data storage services, data temperature, object storage services, database storage services, backup restore, and disaster recovery.	**6**
	Total Lecture Hours	**28**

Suggested Text Book(s):

- Cloud Computing: Concepts, Technology & Architecture, by Zaigham Mahmood, Thomas Erl, Ricardo Puttini, Prentice-Hall, ISBN: 9780133387568
- Wilder, B. (2012). Cloud architecture patterns: using Microsoft azure. " O'Reilly Media, Inc.".

Suggested Reference Book(s):

- Srinivasan, V., Ravi, J., & Raj, J. (2018). Google Cloud Platform for Architects: Design and manage powerful cloud solutions. Packt Publishing Ltd.

Other useful resources (s):

This course is designed based on a famous course provided by Microsoft. Links to courses and content are as follows:

- https://courses.edx.org/courses/course-v1:Microsoft+DEVOPS200.9x+3T2019/course/
- https://azure.microsoft.com/en-in/blog/architecting-distributed-cloud-applications-free-video-course/
- https://www.youtube.com/watch?v=xJMbkZvuVO0&list=PL9XzOCngAkqs0Q8ZRdafnSYExKQurZrBY

EvaluationScheme:

S No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes(2) -10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Architecting Distributed Cloud Applications)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	2	1	1	1	1	1	1	1	1	1	1.4
CO-2	3	3	3	2	2	1	1	1	1	1	3	1	1.8
CO-3	3	3	3	2	2	2	1	1	1	1	3	1	1.9
CO-4	3	3	3	2	2	1	1	1	1	1	3	1	1.8
Average	3	3	2.8	1.8	1.8	1.3	1	1	1	1	2.5	1	1.8

Architecting Distributed Cloud Application Lab

COURSE CODE: XXXXX
COURSE CREDITS: 1
CORE/ELECTIVE: ELECTIVE
L-T-P: 0-0-2
Pre-requisite: Cloud Computing, Basic Networking

Course Objectives:

1. Learn to create a VM on the Microsoft Azure cloud.
2. Create Docker and install container on the docker.
3. Learn to run a network, communication, and storage services for cloud applications on containers.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO1	Install Docker and container. Deploy virtual machine on Microsoft Azure.	Familiarity
CO2	Create sample microservice on cloud container	Usage
CO3	Perform messaging service on cloud containers	Usage
CO4	Learn about storage service on cloud containers	Usage

List of Experiments

S No	Description	Hours
1	Deploy a Microsoft Azure Virtual Machine using free account. Create an account on Visual Studio Team Services (VSTS).	4
2	Install Docker on Ubuntu Machine.	4
3	Create a container image and run the container	4
4	Build a Sample Application with Microservices	4
5	Message Communication of Distributed Cloud Applications	4
6	Storage Services for Distributed Cloud Applications	4
7	Small Project using cloud application services	4
	Total Lab hours	**28**

Suggested/Resources:
This course is designed based on famous course provided by Microsoft. Links to courses and content are as follows:

- https://courses.edx.org/courses/course-v1:Microsoft+DEVOPS200.9x+3T2019/course/
- https://azure.microsoft.com/en-in/blog/architecting-distributed-cloud-applications-free-video-course/

- https://www.youtube.com/watch?v=xJMbkZvuVO0&list=PL9XzOCngAkqs0Q8ZRdafnSYExKQurZrBY

Evaluation Scheme:

S No	Exam	Coverage/Scope of Examination	Marks
1	Mid Term Test	Viva and Written Exam	20
2	End Term Test	Viva and Written Exam	20
3	Lab Records		15
4	Teacher Assessment	(Quality and quantity of experiment performed, learning laboratory skills)	30
5	Attendance and discipline in lab		15
6	Total		100

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Average
CO1	3	3	2	1	1	1	1	1	1	1	1	1	1.4
CO2	3	3	3	2	2	1	1	1	1	1	3	1	1.8
CO3	3	3	3	2	2	2	1	1	1	1	3	1	1.9
CO4	3	3	3	2	2	1	1	1	1	1	3	1	1.8
Average	3	3	2.8	1.8	1.8	1.3	1	1	1	1	2.5	1	1.8

Optimization Methods in Business Analytics

COURSE CODE: XXX
COURSE CREDITS: 3
CORE/ELECTIVE: ELECTIVE
L-T-P: 3-0-0

Pre-requisite: Algorithm design
Course Objectives:

1. Learn the analytics of optimizing algorithms.
2. Learn various computing algorithms in solving complex problems.
3. Apply important algorithmic design paradigms and methods of analysis.
4. Synthesize efficient algorithm design in common engineering design situations.
5. Learn to analyze the specifications and sensitivity of the algorithms.
6. Learn the improvisations of algorithms.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	Comprehension of the design of the optimized algorithm.	Familiarity
CO-2	Demonstrate familiarity with major algorithms.	Assessment
CO-3	Analyze the different types of algorithms.	Assessment
CO-4	Apply algorithms for simulating the decision.	Usage

Course Contents:

Unit	Contents	Lectures Required
1	**Introduction to optimization technique:** Examples of optimization problems: Shortest path problem, integer knapsack; Unconstrained optimization; Unconstrained optimization; Convex set and Convex function; Duality: Geometric interpretation, Lagrangian Saddle point, Weak and strong duality.	8
2	**Linear programming:** Linear programming problem; Basic feasible solution; Geometric solution; Optimality condition and simplex method; Two-phase simplex method; Interior point method, Duality in linear programming, Karmarkars method.	8
3	**Transportation problem:** Characteristics of transportation problem; Northwest Corner Method; Least Cost Method; Vogel's Approximation Method **Assignment problem:** Characteristics of assignment problem, Hungarian methods, Dual of assignment problem, optimality of Hungarian methods.	6

4	**Integer programming:** Complexity of simplex methods**;** Elementary notions; Formulation; Solving 0-1 problem; Branch-Bound for integer programming; Cutting plane problem; All integer primal and Dual algorithm;	**8**
5	**Network models:** Characteristics of network models; Shortest path problem; Successive shortest path problem; Maximum flow problem; Minimum cost flow problem.	**6**
6	**Nonlinear programming:** Quadratic programming: Lagrange multiplier and KKT, Steepest descent method. **Sensitivity analysis:** dummy variable, linear programming, integer linear programming, nonlinear models and statistical test: t-test, chi-square test, Wilcoxon signed-rank	**6**
	Total Lecture Hours	**42**

Suggested Text Book(s):

- Singiresu S. Rao, Engineering Optimization: Theory and Practice by John Wiley and Sons, 4th edition, 2009.
- H. S. Kasane & K. D. Kumar, Introductory Operations Research, Springer (India), Pvt. Ltd., 2004
- Optimization for Engineering Design. K Deb.

Suggested Reference Book(s):

- Sheskin, David J. (2003) Handbook of Parametric and Nonparametric Statistical Procedures. CRC Press.
- Optimization concepts and applications in engineering, A. D. Belegundu and T. R. Chandrupatla.
- Linear and Nonlinear programming. Stephen G. Nash and A. sofer

Other useful resources (s):

- Link to NPTEL course contents: https://nptel.ac.in/courses/111/105/111105039/
- Link to NPTEL course contents: https://nptel.ac.in/courses/111/104/111104068/
- Link to NPTEL course contents: https://nptel.ac.in/courses/112/106/112106131/

Link to topics related to course:

- https://nptel.ac.in/courses/112/106/112106134/
- https://nptel.ac.in/courses/112/106/112106131/
- https://nptel.ac.in/courses/106104019/26
- https://nptel.ac.in/courses/111/105/111105039/

Evaluation Scheme:

S No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Optimization Methods in Business Analytics)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	1.8
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	2
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	1.8
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	2.1
Average	2	2.5	2.5	2.5	2.5	1	1	1	2	2.3	1.5	2	1.9

From Graph to Knowledge Graph

COURSE CODE: XXX
COURSE CREDITS: 2
CORE/ELECTIVE: ELECTIVE
L-T-P: 2-0-0
Pre-requisite: Basic programming skills
Course Objectives:

1. You will learn graph representations.
2. Understand the entire process of how to design, construct, and query a knowledge graph to solve real-world problems.
3. Understand how to apply the tools and infrastructure to build and query knowledge graphs.
4. Use knowledge graphs in modern search applications.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	Learn graph representations	Familiarity
CO-2	Utilize fundamentals to build knowledge graphs	Assessment
CO-3	Understand the algorithms and techniques for crawling web sites, structured data extraction, and information extraction from unstructured text.	Assessment
CO-4	Understand how to apply the tools and infrastructure to build and query knowledge graphs.	Usage

Course Contents:

Unit	Contents	Lectures Required
1	Introduction and Overview Introduction to Graphs, Introduction to Knowledge graphs	**4**
2	Graph Properties and Applications: Graph basics, Graph Applications	**4**
3	Graph Representation Learning Embeddings and Graph Embeddings	**4**
4	Knowledge Graph (KG) - Fundamentals and Construction. KG Fundamentals How to Build a Knowledge Graph	**5**
5	Knowledge Graph (KG) - Inference and Applications KG Inference. How to Use a Knowledge Graph Why We Need Knowledge Graphs: Applications KG Applications	**6**
6	Knowledge graph analytics	**5**
	Total Lecture Hours	**28**

Suggested Text Book(s):

- Fensel, Dieter (et al.), "Knowledge Graphs Methodology, Tools and Selected Use Cases", Springer, 2020.
- Qi, G. et. al, "Knowledge Graph", Springer, 2020, ISBN 978-981-10-8177-4

Suggested Reference Book(s):

- Jeff Z. Pan, Guido Vetere, Jose Manuel Gomez-Perez, Honghan Wu, " Exploiting Linked Data and Knowledge Graphs in Large Organisations", Springer International Publishing, Print ISBN 978-3-319-45652-2, DOI https://doi.org/10.1007/978-3-319-45654-6
- Mayank Kejriwal, "Domain-Specific Knowledge Graph Construction", Springer, DOI: 10.1007/978-3-030-12375-8

Other useful resources (s):

- Journal, "Knowledge-Based Systems", Springer

Evaluation Scheme:

S No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (From Graph to Knowledge Graph)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	1.8
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	2
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	1.8
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	2.1
Average	2	2.5	2.5	2.5	2.5	1	1	1	2	2.3	1.5	2	1.9

From Graph to Knowledge Graph Lab

COURSE CODE: XXX
COURSE CREDITS: 1
CORE/ELECTIVE: ELECTIVE
L-T-P: 0-0-2
Pre-requisite: Basic programming skills

Course Objectives:

1. The lab is designed to provide a versatile means to perform learning tasks over a knowledge graph.
2. Use Machine Learning over a Knowledge Graph

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO1	Build a knowledge graph from documents	Usage
CO2	Building a knowledge graph from a text	Usage
CO3	Build a Small Knowledge Graph	Usage
CO4	Understand the Graph Databases	Assessment
CO5	Familiarity with graph computing Frameworks	Familiarity
CO6	Able to Visualization of graphs	Assessment

List of Experiments

S No	Description	Hours
1	Introduction to Linked Data. Loan Prediction Practice Problem (Using Python) Build a knowledge graph from documents	4
2	Build a Small Knowledge Graph Creating and Processing Linked Data Building a knowledge graph from text A Knowledge Graph understanding and implementation	4
3	Build a Small Knowledge Graph Building a knowledge graph in python from scratch	4
4	Introduction to Graph Databases A Python Library for Knowledge Graph Embedding	6
5	Introduction to graph computing Frameworks	4
6	Introduction to Graph Visualization	6
	Total Lab hours	**28**

Suggested/Resources:

- Grakn KGLIB (Knowledge Graph Library) https://github.com/.
- Online resources.

- Fensel, Dieter (et al.), "Knowledge Graphs Methodology, Tools and Selected Use Cases", Springer, 2020.

Evaluation Scheme:

S No	Exam	Coverage/Scope of Examination	Marks
1	Mid Term Test	Viva and Written Exam	20
2	End Term Test	Viva and Written Exam	20
3	Lab Records		15
4	Teacher Assessment	(Quality and quantity of experiment performed, learning laboratory skills)	30
5	Attendance and discipline in lab		15
6	Total		100

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Avg
CO1	3	3	3	3	2	2	1	1	1	1	1	1	**1.83**
CO2	3	3	3	3	3	1	1	1	1	1	1	3	**2.00**
CO3	3	3	2	3	2	3	2	1	1	1	2	1	**2.00**
CO4	3	3	3	2	3	2	1	1	1	1	1	1	**1.83**
CO5	2	2	3	3	3	3	1	1	1	1	1	1	**1.83**
C06	2	3	3	3	2	2	2	2	2	2	2	2	**2.25**
Avg	**2.67**	**2.83**	**2.80**	**2.80**	**2.60**	**2.20**	**1.20**	**1.00**	**1.00**	**1.00**	**1.20**	**1.40**	

Probabilistic Graphical Models

COURSE CODE: XXX
COURSE CREDITS: 3
CORE/ELECTIVE: ELECTIVE
L-T-P: 3-0-0
Pre-requisite: Machine learning and Probability
Course Objectives:

1. Learn introductory concepts in probabilistic graphical models.
2. Able to model problems using graphical models.
3. Able to model problems using design inference algorithms.
4. Learn the structure of the graphical model from data

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	Learn introductory concepts in probabilistic graphical models	Familiarity
CO-2	Able to model problems using graphical models.	Assessment
CO-3	Able to model problems using design inference algorithms.	Assessment
CO-4	Analyze the structure of the graphical model from data	Usage

Course Contents:

Unit	Contents	Lectures Required
1	**Fundamentals I**: Fundamentals of Probability Theory - Views of Probability, Random Variables and Joint Distributions, Conditional Probability, Conditional Independence, Expectation and Variance, Probability Distributions - Conjugate Priors, Introduction to Exponential Family;	**3**
2	**Fundamentals II**: Fundamentals of Graph Theory – Nodes and Edges, Paths and Trails, Cliques, Subgraphs, Cycles, and Loops.	**3**
3	**Graphical Models** I: Introduction - Directed Models (Bayesian Network), Undirected Models (Markov Random Fields), Dynamic Models (Hidden Markov Model & Kalman Filters) and Factor Graph;	**6**
4	**Graphical Models II**: Conditional Independence (Bayes Ball Theorem and D-separation), Markov Blanket, Factorization (Hammersley-Clifford Theorem), Equivalence (I-Maps & Perfect Maps); Factor Graphs - Representation, Relation to Bayesian Network and Markov Random Field.	**6**
5	**Inference in graphical models I**: Exact Inference - Variable Elimination, Elimination Orderings, Relation to Dynamic Programming, Dealing with Evidence, Forward-Backward Algorithm, Viterbi Algorithm; Junction Tree Algorithm; Belief Propagation (Sum-Product);	**6**

6	**Inference in graphical models I** I: Approximate Inference - Variational Methods (Mean Field, Kikuchi & Bethe Approximation), Expectation Propagation, Gaussian Belief Propagation; MAP Inference - Max-Product, Graph Cuts, Linear Programming Relaxations to MAP (Tree-Reweighted Belief Propagation, MPLP); Sampling - Markov Chain Monte Carlo, Metropolis Hastings, Gibbs (Collapsing & Blocking), Particle filtering	**6**
7	**Learning in Graphical Models I:** Overview, Parameter Estimation - Expectation Maximization, Maximum Likelihood Estimation, Maximum Entropy, Pseudolikelihood, Bayesian Estimation, Conditional Likelihood,	**6**
8	**Learning in Graphical Models II:** Structured Prediction; Learning with Approximate Inference; Learning with Latent Variables; Structure Learning, Structure Search, L1 priors.	**6**
	Total Lecture Hours	**42**

Suggested Text Book(s):

- Koller, D. and Friedman, N. (2009). Probabilistic Graphical Models: Principles and Techniques. MIT Press.

Suggested Reference Book(s):

- Jensen, F. V. and Nielsen, T. D. (2002). Bayesian Networks and Decision Graphs. Information Science and Statistics. Springer, 2nd edition.
- Kevin P. Murphy (2013) Machine Learning: A Probabilistic Perspective. 4th Printing. MIT Press.
- Barber, D. (2011). Bayesian Reasoning and Machine Learning. Cambridge University Press, 1st edition.
- Bishop, C. M. (2011). Pattern Recognition and Machine Learning (Information Science and Statistics). Springer, 2nd printing.
- Wainwright, M. and Jordan, M. (2008). Graphical Models, Exponential Families, and Variational Inference. Foundations and Trends in Machine Learning, 1:1–305.

Other useful resource(s):

- Conference papers and journal articles

Evaluation Scheme:

S No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Probabilistic Graphical Models)	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**Average**
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	**1.75**
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	**2**
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	**1.75**
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	**2.08**
Average	**2**	**2.5**	**2.5**	**2.5**	**2.5**	**1**	**1**	**1**	**2**	**2.25**	**1.5**	**2**	1.89

Image Analysis and Pattern Recognition

COURSE CODE: XXX
COURSE CREDITS: 2
CORE/ELECTIVE: ELECTIVE
L-T-P: 2-0-0

Pre-requisites: Linear algebra, Matrices, Matrix Operations, Determinants, Systems of Linear Equations, Eigenvalues, Eigenvectors, Statistics and probability, Programming experience, preferably in MATLAB, and/or C/C++/C#/Python/Java

Course Objective:
The course aims to introduce the student to various image processing techniques. The student learns about image fundamentals, describes the main characteristics of digital images, how they are represented, mathematical transforms such as Fourier, Cosine transforms, Singular value decomposition, 2D Wavelet transform, image enhancement techniques, Image restoration and denoising, segmentation, lossy and lossless data compression algorithms, binary and color image processing. The student will be exposed to dealing with image data through programming assignments using MatLab, and/or C/C++/C#/Python/Java.

Course Outcome:
Upon completion of this course, a successful student should be able to design and implement programs that deal with image data.

- To understand how digital images are represented, manipulated, encoded, and processed, with emphasis on algorithm design, implementation, and performance evaluation.
- Emphasis will be to develop engineering skills and intuitive understanding of the tools used in Image Processing.
- The students would be encouraged to design and develop the image processing algorithms/tools for real-life problems.

Course Outcomes:

S No	Course outcomes	Level of Attainment
CO-1	To understand the different images and their processing	Familiarity
CO-2	To understand the concept of Image transformation Algorithms/techniques	Assessment
CO-3	To understand the concepts of lossy and Lossless compression Algorithms/techniques	Assessment
CO-4	To understand the concepts of Image enhancement and Segmentation Algorithms/techniques	Assessment
CO-5	To understand the concepts of Image Restoration and Denoising Algorithms/techniques	Technical skills
CO-6	To understand the concepts of Binary and Color image processing	Assessment

CO-7	To understand the concepts of Object recognition decision-theoretic methods and structural methods	Technical skills

Course contents:

Unit	Topic	Lectures required
1	**Introduction to Digital Image Processing** Introduction to images and its processing, Components of image processing systems, image representations, Image file formats, Applications of digital image processing, image sampling, and quantization, Image Analysis, Intensity transformations, contrast stretching, Correlation, and convolution, Smoothing filters, sharpening filters, gradient, and Laplacian.	3
2	**Image Transformation Techniques** Need for transform, Fourier, Cosine transforms, Haar, KL Transform, Singular value decomposition, 2D Wavelet transform, Different properties of image transform techniques.	4
3	**Image Compression Basics** Concept of image compression, lossless techniques (Huffman Coding, Arithmetic, and Lempel-Ziv Coding, Other Coding Techniques) and lossy compression techniques (Transform Coding & K-L Transforms, Discrete Cosine Transforms, and BTC), Multi-Resolution Analysis, and Still Image Compression Standards (JBIG and JPEG),	4
4	**Image Enhancement** **Enhancement in spatial and transform domain,** histogram equalization DirectionalSmoothing, Median, Geometric mean, Harmonic mean, Contrahar monic mean filters, Homomorphic filtering, Color image enhancement.	3
5	**Image Restoration and Denoising** Image degradation, Type of image blur, Classification of image restoration techniques, image restoration model, Linear, and non-linear restoration techniques, Image denoising, Median filtering	3
6	**Image Segmentation** **Classification of image segmentation techniques,** Boundary detection based techniques, Point, line detection, Edge detection, Edge linking, local processing, regional processing, Hough transform, Thresholding, Iterative thresholding, Otsu's method, Moving averages, Multivariable thresholding, Region-based segmentation, Watershed algorithm, Use of motion in segmentation	4
7	**Binary and Color image processing** Binarization, Basic Set theory, Binary morphological operations, and its properties, Color Image Representation in MATLAB, Converting Between Color Spaces, The Basics of Color Image Processing, Color Transformations, Spatial Filtering of Color Images, Working Directly in RGB Vector Space	3
8	**Object Recognition** **Decision theoretic methods:** Matching, Optimal statistical Classifier, Neural network.	4

	Structural methods: Matching shape numbers, String matching, Syntactic recognition of string, Syntactic recognition of tree.	
	Total Lecture Hours	**28**

Recommended Books

- Digital Image Processing, R.C. Gonzalez and R.E. Woods, 2nd edition, Pearson Prentice Hall, 2008
- Anil K. Jain, *Fundamentals of Digital Image Processing*, Prentice-Hall, 1989.
- Digital Image processing, S Jayaraman, TMH, 2012
- William K. Pratt, *Digital Image Processing*, 3rd Edition, John Wiley, 2001.

Evaluation Scheme:

S No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Avg
CO1	3	3	3	2	3	3	2	2	2	2	2	3	2.5
CO2	3	3	3	2	2	2	2	2	2	2	2	3	2.3
CO3	3	3	3	2	3	2	2	2	2	2	2	3	2.4
CO4	3	3	3	2	3	2	2	2	2	2	2	3	2.4
CO5	3	3	3	2	3	2	2	2	2	2	2	3	2.4
CO6	3	3	3	2	3	2	2	2	2	2	2	3	2.4
CO7	3	3	3	3	3	3	2	2	3	2	3	3	2.8
Avg	3	3	3	2.1	2.9	2.3	2	2	2.1	2	2.1	3	2.5

Image Analysis and Pattern Recognition Lab

COURSE CODE: XXX
COURSE CREDITS: 1
CORE/ELECTIVE: ELECTIVE
L-T-P: 0-0-2

Pre-requisite: programming, algorithm, matrix operations
Course Objectives: In this lab, you will implement image processing techniques that you will learn during the frontal course. Work in the lab will be carried out in Matlab and OpenCV

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO1	Introduction to basic image processing operations and histogram algorithms	Familiarity
CO2	Introduction to image filtering in spatial and in frequency domains.	Assessment
CO3	Introduction to image restoration.	Assessment
CO4	Introduction of principles of the JPEG baseline coding system.	Assessment
CO5	Getting familiar with the OpenCV library. Basic processing of color images and introduction to video tracking using the Camshaft algorithm.	Technical skills
CO6	Analyze the systems using Laplace transform and Z-transform.	Assessment

List of Experiments

S No	Description	Hours
1	Introduction to MATLAB. In this lab, we will study basic image-processing operations: image resizing and rotation, quantization, and histogram algorithms. We will analyze the effects of resizing and quantization on image quality and the methods to improve the quality and avoid artifacts. Histogram techniques allow us to analyze the distribution of gray levels in an image. In this lab, we will study histogram, histogram normalization, and histogram equalization. Understand the basics of MATLAB syntax, functions, and programming.	**4**
2	In this lab, we'll study the properties of DFT and two practical applications: 1. Computation of convolution by two methods – direct method (in the spatial domain) and indirect method (in the frequency domain). 2.Computation of edge enhancement by unsharp masking.	**4**
3	In practical imaging systems, the acquired image often suffers from the effects of blurring and noise. Image restoration algorithms are aimed to restore the original undistorted image from its blurry and noisy version. The lab experiment demonstrates the evolution of restoration algorithms from the simple Inverse Filter, Pseudo Inverse Filter, and Wiener Filter	**4**
	Mid sem exam	**2**

4	In this lab, we will present the basic concepts used for JPEG coding and experiment with different coding parameters. The JPEG standard provides a powerful compression tool used worldwide for different applications. This standard has been adopted as the leading lossy compression standard for natural images due to its excellent compression capabilities and its configurability.	**4**
5	OpenCV is an open-source computer vision library, written in C and C++. One of the main goals of OpenCV is to provide a simple-to-use computer vision infrastructure that helps people to build sophisticated vision applications quickly. Among the tools provided by OpenCV are image transformations, histograms, video tracking, 3D vision algorithms, and machine learning.	**4**
6	Implementation of Camshaft algorithm, Mean-shift algorithm and Adaptive adjustment	**4**
	End-semester Exam	**2**
	Total Lab hours	**28**

Suggested/Resources:

- R. C. Gonzalez, R. E. Woods and S. L. Eddins, *Digital Image Processing using MATLAB*. Pearson Education, Inc., 2004 (Library Dewey number 621.368 GON).
- OpenCV library: http://SourceForge.net/projects/opencvlibrary

Evaluation Scheme:

S No	Exam	Coverage/Scope of Examination	Marks
1	Mid Term Test	Viva and Written Exam	20
2	End Term Test	Viva and Written Exam	20
3	Lab Records		15
4	Teacher Assessment	(Quality and quantity of experiment performed, learning laboratory skills)	30
5	Attendance and discipline in lab		15
6	Total		100

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Avg
CO1	3	3	3	3	2	2	1	1	1	1	1	1	1.8
CO2	3	3	3	3	3	1	1	1	1	1	1	3	2
CO3	3	3	2	3	2	3	2	1	1	1	2	1	2
CO4	3	3	3	2	3	2	1	1	1	1	1	1	1.8
CO5	2	2	3	3	3	3	1	1	1	1	1	1	1.8
CO6	2	3	3	3	2	2	2	2	2	2	2	2	2.3
Avg	2.7	2.8	2.8	2.8	2.5	2.2	1.3	1.2	1.2	1.2	1.3	1.5	2

Statistics and Exploratory Data Analytics

COURSE CODE: XXX
COURSE CREDITS: 2
CORE/ELECTIVE: ELECTIVE
L-T-P: 2-0-0
Pre-requisite: None
Course Objectives:

1. Learn the basic concept of statistics and exploratory data analysis.
2. Learn graphical and modeling techniques for exploring data.
3. Learn Data Transformation and dimensionality reduction of data.
4. Learn data clustering and scatter plots.
5. Apply exploratory data analysis techniques to visualized data.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	Analyze the concept of statistics and exploratory data analysis.	Familiarity
CO-2	Graphical and modeling techniques for exploring data.	Assessment
CO-3	Implement data transformation, dimensionality reduction	Assessment
CO-4	Apply data clustering and visualized exploratory data through various plots and graphs.	Usage

Course Contents:

Unit	Contents	Lectures required
1	**Concept of statistics and exploratory data analysis:** Introduction of data and its types (categorical and quantitative), Central Tendency: mean, median, mode, variance, standard deviation, skewness, kurtosis, exploratory data analysis, and its types, data dimensionality.	**5**
2	**Graphical and modeling techniques for exploratory data:** Box Plot, Histogram, Multi-Vari Chart, Run Chart, Pareto Chart, Scatter Plot, Stem-and-leaf plot.	**5**
3	**Data transformation, dimensionality reduction**: Power transformation, standardization, multidimensional scaling, principal component analysis, linear or non-linear dimensionality reduction.	**7**
4	**Data Clustering Techniques:** Data clustering, Hierarchal methods, optimization method, k-means, and model-based clustering.	**5**
5	**Smoothing scatter plots and graphical methods for EDA:** Bivariate distribution smooths, curve fitting toolbox, Dendrogram, treemaps, rectangle plots.	**6**
	Total Lecture Hours	**28**

Suggested Text Book(s):

- Martinez, W. L.; Martinez, A. R. & Solka, J. (2010). *Exploratory Data Analysis with MATLAB, second edition*. Chapman & Hall/CRC.
- Hoaglin, D C; Mosteller, F & Tukey, John Wilder (Eds) (1983). *Understanding Robust and Exploratory Data Analysis*.
- Andrienko, N & Andrienko, G (2005) *Exploratory Analysis of Spatial and Temporal Data. A Systematic Approach*

Suggested Reference Book(s):

- Tukey, John Wilder (1977). *Exploratory Data Analysis*. Addison-Wesley

Evaluation Scheme:

S No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Statistics and Exploratory Data Analytics)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	1.8
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	2
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	1.8
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	2.1
Average	2	2.5	2.5	2.5	2.5	1	1	1	2	2.3	1.5	2	1.9

Statistics and Exploratory data analytics Lab

COURSE CODE: XXX
COURSE CREDITS: 1
CORE/ELECTIVE: ELECTIVE
L-T-P: 0-0-2
Pre-requisite: Basic knowledge of python programming and Matlab.
Course Objectives:

1. Learn to explore a dataset
2. Visualization of data
3. Dimensionality reduction of data
4. Cluster findings in a dataset
5. Usage of curve fitting tools

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO1	Understand the basics of MATLAB syntax/python libraries	Familiarity
CO2	Exploring dataset and visualizing data on different charts.	Assessment
CO3	Perform the basic operations of data pre-processing and dimensionality reduction.	Assessment
CO4	Design and analyze clustering techniques.	Usage
CO5	Understanding of curve fitting toolbox.	Usage
CO6	Implementation of dendrogram and treemaps.	Usage

List of Experiments

S No	Description	Hours
1	Introduction to MATLAB/Python Libraries	**2**
2	Exploring dataset and data preprocessing	**2**
3	Importing dataset in python	**2**
4	Implementation of standard deviation and skewness of data	**2**
5	Visualizing data on a histogram	**2**
6	Implementations of the box plot chart	**2**
7	Implementation of data representation in the pie chart	**2**
8	Implementation of data representation in scatter plot	**2**
9	Implementation of a column chart	**2**
10	Implementation of principal component analysis techniques	**2**
11	Implementation of nonlinear dimensionality reduction	**2**
12	Finding cluster in a dataset	**2**
13	Implementation of hierarchal clustering techniques	**2**
14	Implementation of curve fitting toolbox	**2**
	Total Lab hours	**28**

Suggested/Resources:

- Martinez, W. L.; Martinez, A. R. & Solka, J. (2010). *Exploratory Data Analysis with MATLAB, second edition*. Chapman & Hall/CRC.
- Hoaglin, D C; Mosteller, F & Tukey, John Wilder (Eds) (1983). *Understanding Robust and Exploratory Data Analysis.*

Evaluation Scheme:

S No	Exam	Coverage/Scope of Examination	Marks
1	Mid Term Test	Viva and Written Exam	20
2	End Term Test	Viva and Written Exam	20
3	Lab Records		15
4	Teacher Assessment	(Quality and quantity of experiment performed, learning laboratory skills)	30
5	Attendance and discipline in lab		15
6	Total		100

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Avg
CO1	3	3	3	3	2	2	1	1	1	1	1	1	**1.83**
CO2	3	3	3	3	3	1	1	1	1	1	1	3	**2.00**
CO3	3	3	2	3	2	3	2	1	1	1	2	1	**2.00**
CO4	3	3	3	2	3	2	1	1	1	1	1	1	**1.83**
CO5	2	2	3	3	3	3	1	1	1	1	1	1	**1.83**
C06	2	3	3	3	2	2	2	2	2	2	2	2	**2.25**
Avg	**2.67**	**2.83**	**2.80**	**2.80**	**2.60**	**2.20**	**1.20**	**1.00**	**1.00**	**1.00**	**1.20**	**1.40**	

Information Visualization

COURSE CODE: XXX
COURSE CREDITS: 3
CORE/ELECTIVE: ELECTIVE
L-T-P: 3-0-0
Pre-requisite: Basic mathematics courses

Course Objectives:

1. Information visualization offers instruments for reasoning about quantitative information, analyzing, and communicating statistical information.
2. The course overviews the main typologies of data graphics (data-maps, time-series, space-time narrative, relational diagrams, graphs and methods for dimensionality reduction)
3. The course provides a language for discussing data visualizations combined with knowledge of the human perception of visual objects.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	Big Data and Large-Scale Computation, Web Technologies	Familiarity
CO-2	Applications and Science, Signal Processing and Data Science tracks	Assessment
CO-3	Game Design and Production and Machine Learning, Data Science and Artificial Intelligence majors	Assessment
CO-4	Machine Learning, Data Science and Artificial Intelligence, Analytics and Data Science minor.	Usage
CO-5	ICT Innovation program's Data Science, Digital Media Technology, Human-Computer Interaction minor, and Life Science Technologies Complex Systems major and minor and Bioinformatics and Digital Health minor.	Usage

Course Contents:

Unit	Contents	Lectures required
1	**Foundations for an Applied Science of Data Visualization:** Visualization Stages, Experimental Semiotics Based on Perception, Semiotics of Graphics, Sensory versus Arbitrary Symbols, Gibson's Affordance Theory, A Model of Perceptual Processing, Costs and Benefits of Visualization, Types of Data, Metadata	**6**
2	**The Environment, Optics, Resolution, and the Display:** The Environment, The Eye, The Optimal Display	**4**
3	**Lightness, Brightness, Contrast, and Constancy:** Neurons, Receptive Fields, and Brightness Illusions, Luminance, Brightness, Lightness, and	**4**

	Gamma, Perception of Surface Lightness, Monitor Illumination and Monitor Surrounds	
4	**Color:** Trichromacy Theory, Color Measurement, Opponent Process Theory, Properties of Color Channels, Color Appearance, Applications of Color in Visualization	**4**
5	**Visual Salience and Finding Information:** Eye Movements, V1, Channels, and Tuned Receptors, Preattentive Processing and Ease of Search, Integral and Separable Dimensions: Glyph Design, Representing Quantity, The Searchlight Metaphor and Cortical Magnification	**6**
6	**Static and Moving Patterns:** Gestalt Laws, Texture: Theory and Data Mapping, Perception of Transparency: Overlapping Data, Perceiving Patterns in Multidimensional Discrete Data, Pattern Learning, The Visual Grammar of Node–Link Diagrams, The Visual Grammar of Maps, Patterns in Motion, Perception of Animated Motion, The Processes of Pattern Finding	**6**
7	**Space Perception:** Depth Cue Theory, Depth Cues in Combination, Task-Based Space Perception, Tracing Data Paths in 3D Graphs, Judging the Morphology of Surfaces, Patterns of Points in 3D Space, Perceiving Patterns in 3D Trajectories, Judging Relative Positions of Objects in Space, Judging the Relative Movements of Self within the Environment, Selecting and Positioning Objects in 3D, Judging the "Up" Direction, The Aesthetic Impression of 3D Space (Presence)	**6**
8	**Visual Objects and Data Objects:** Image-Based Object Recognition, Structure-Based Object Recognition, The Object Display, and Object-Based Diagrams, Faces, Coding Words and Images, Labels and Concepts, Concept Mapping, Iconic Images versus Words versus Abstract Symbols, Scenes and Scene Gist	**6**
Total lectures		**42**

Suggested Text Book(s):

- Ware, C., 2020. Information visualization: perception for design. Morgan Kaufmann.

Suggested Reference Book(s):

- Bederson, B.B., Bederson, B.B., and Shneiderman, B. eds., 2003. The craft of information visualization: readings and reflections. Morgan Kaufmann.
- Bergman, E. ed., 2000. Information appliances and beyond: interaction design for consumer products. Morgan Kaufmann.

Other useful resources (s):

- https://www.youtube.com/watch?v=t0B2sxIumh0&list=PLk_jmmkw5S2C1A_ZD3mpBb3Og_Y1QZ83Z
- https://www.youtube.com/watch?v=IKSRwGZe8Oc

Evaluation Scheme:

S No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes(2) -10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Information Visualization)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	1.8
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	2
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	1.8
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	2.1
CO-5	2	3	3	3	2	1	1	1	2	3	2	2	2.1
Average	2	2.6	2.6	2.6	2.4	1	1	1	2	2.4	1.6	2	

Introduction to Deep Learning

COURSE CODE: XXX
COURSE CREDITS: 3
CORE/ELECTIVE: ELECTIVE
L-T-P: 3-0-0
Pre-requisite:
1) Basic knowledge of Python.
2) Basic linear algebra and probability.

Course Objectives:

1. The goal of this course is to give learners a basic understanding of modern neural networks and their applications in computer vision and natural language understanding.
2. The course starts with a recap of linear models and discussion of stochastic optimization methods that are crucial for training deep neural networks.
3. Learners will study all popular building blocks of neural networks including fully connected layers, convolutional and recurrent layers.
4. Learners will use these building blocks to define complex modern architectures in TensorFlow and Keras frameworks.
5. In the course, project learner will implement a deep neural network for the task of image captioning which solves the problem of giving a text description for an input image.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	Linear regression: mean squared error, analytical solution.	Familiarity
CO-2	Logistic regression: model, cross-entropy loss, class probability estimation	Assessment
CO-3	Gradient descent for linear models. Derivatives of MSE and cross-entropy loss functions.	Assessment
CO-4	The problem of overfitting.	Usage
CO-5	Regularization for linear models.	Usage

Course Contents:

Unit	Contents	Lectures Required
1	**Introduction to optimization:** Linear regression, Linear classification Gradient descent, Overfitting problem and model validation, Model regularization, Stochastic gradient descent, Gradient descent extensions9m	**8**

2	**Introduction to neural networks:** Multilayer perceptron (MLP), Chain rule, Backpropagation, Efficient MLP implementation, Other matrix derivatives, what is TensorFlow, our first model in TensorFlow, What Deep Learning is and is not, Deep learning as a language	**8**
3	**Deep Learning for images:** Motivation for convolutional layers11m Our first CNN architecture, Training tips and tricks for deep CNNs, Overview of modern CNN architectures, Learning new tasks with pre-trained CNNs, A glimpse of other Computer Vision tasks8m	**6**
4	**Unsupervised representation learning:** Unsupervised learning: what it is and why bother, Autoencoders 10, Autoencoder applications, Autoencoder applications: image generation, data visualization & more, Natural language processing primer, Word embeddings, Generative models 10, Generative Adversarial Networks, Applications of adversarial approach	**6**
5	**Deep learning for sequences:** Motivation for recurrent layers, Simple RNN and Backpropagation, The training of RNNs is not that easy, Dealing with vanishing and exploding gradients, Modern RNNs: LSTM and GRU, Practical use cases for RNNs	**8**
6	**Final Project:** This week you will apply all your knowledge about neural networks for images and texts for the final project. You will solve the task of generating descriptions for real-world images!	**6**
	Total Lecture Hours	**42**

Suggested Text Book(s):

Ian Goodfellow, YoshuaBengio, and Aaron Courville, "Deep Learning", The MIT Press, Cambridge, 2016.

- Charu C. Aggarwal, "Neural Networks and Deep Learning: A Textbook", Springer, 2018.

Suggested Reference Book(s):

- Josh Patterson, Adam Gibson, "Deep Learning: A Practitioner's Approach", 2nd Edition, OReilly Media
- Andrew Ng, "Machine Learning Yearning", available online published by deeplearning.ai

Other useful resources (s):

- http://www.charuaggarwal.net/neural.htm
- https://www.coursera.org/specializations/deep-learning

Evaluation Scheme:

S No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes(2) -10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Introduction to Deep Learning)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	1.8
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	2
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	1.8
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	2.1
CO-5	2	3	3	3	2	1	1	1	2	3	2	2	2.1
Average	2	2.6	2.6	2.6	2.4	1	1	1	2	2.4	1.6	2	

Social Media

COURSE CODE: XXX
COURSE CREDIT: 2
CORE/ELECTIVE: ELECTIVE
L-T-P: 2-0-0
Pre-requisites: Graph Theory, Probability

Course Objectives:

1. Understanding the social media structure.
2. Understanding graph theory, particularly the algebraic description and analysis of graphs and their use in social media studies.
3. Helping scientists, artists, and sociologists understand complex social media phenomena like information diffusion, marketing, and recommendation systems in social media and evolving systems.
4. Acquiring expertise to analyze the social and digital media markets.
5. Providing insight into processing, storing, and visualizing big social media data and social graphs.

Course outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	Understand what constitutes Social and Digital Media	Familiarity
CO-2	Algebraic Graph Analysis	Assessment
CO-3	Design effective and reliable network research projects	Assessment
CO-4	Matrix and Tensor Factorization with Recommender System Applications	Assessment
CO-5	Graph Signal Processing in Social Media	Assessment
CO-6	Big Data Analytics for Social Networks	Assessment

Course Contents:

Unit	Topics	Lectures Required
1	**Graphs in Social and Digital Media** - Dominant social networking/media platforms, Collecting data from social media sites, Social media graphs, Big data issues in social and digital media	3
2	**Mathematical Preliminaries:** Graphs and Matrices & Algebraic Graph Analysis, Matrix decompositions, Applications of graph analysis, Graph clustering, Graph anomaly detection	3
3	**Web Search Based on Ranking** - Information Retrieval, Background, Relevance Beyond the Web Page, Ranking in Heterogeneous Networks	3
4	**Label Propagation and Information Diffusion in Graphs** - Graph construction approaches, Label inference methods,	3

	Diffusion processes, Social network diffusion models	
5	**Graph-Based Pattern Classification and Dimensionality Reduction** - Unsupervised Methods, Supervised Methods, Semi-Supervised Methods	3
6	**Matrix and Tensor Factorization with Recommender System Applications** - Singular Value Decomposition on Matrices for Recommender Systems, Higher Order Singular Value Decomposition (HOSVD) on Tensors A Real Geo-Social System-Based on HOSVD	3
7	**Multimedia Social Search Based on Hypergraph Learning** – Hypergraphs, Game-Theoretic approaches to uniform hypergraph clustering, Spectral clustering for arbitrary hypergraphs	3
8	**Semantic Model Adaptation for Evolving Big Social Data** - Latent Model Adaptation, Parallel and Distributed Approaches for Big Data Analysis, Applications to Evolving Social Data Analysis	3
		28

Suggested Text Book(s):

- Pitas, Ioannis, ed. Graph-based social media analysis. Vol. 39. CRC Press, 2016.

Suggested Reference Book(s):

- Analyzing Social Networks 1st Edition by Stephen P Borgatti, Martin G. Everett, Jeffrey C. Johnson, SAGE Publications Ltd; 1 edition
- Influence and Behavior Analysis in Social Networks and Social MediabyMehmet Kaya, Reda Alhajj, Lecture Notes in Social Networks, Springer International Publishing
- Emerging Research Challenges and Opportunities in Computational Social Network Analysis and Mining by Nitin Agarwal, NimaDokoohaki, Serpil Tokdemir, Lecture Notes in Social Networks, Springer International Publishing

Evaluation Scheme:

S No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 hour.	Syllabus covered upto Test-1
2	T-2	25	1.5 hours	Syllabus covered upto Test-2
3	T-3	35	2 hours	Syllabus covered upto Test-3
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) -10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Avg
CO-1	3	3	3	2	2	3	2	2	2	3	1	3	2.4
CO-2	3	3	3	2	3	2	3	2	2	3	1	3	2.5
CO-3	3	3	3	2	2	3	1	2	3	3	1	3	2.4
CO-4	3	3	3	2	3	3	2	2	3	3	1	3	2.6
CO-5	3	3	3	2	3	3	2	2	3	3	1	3	2.6
CO-6	3	3	3	2	3	3	2	2	1	3	1	3	2.4
Average	3	3	3	2	2.7	2.8	2	2	2.3	3	1	3	

Social Media Lab

COURSE CODE: XXX
COURSE CREDIT: 1
CORE/ELECTIVE: ELECTIVE
L-T-P: 0-0-2
Pre-requisites: Graph Theory, Probability, Statistics
Course Objectives:

1. To create a sustainable software and technical ecosystem driven by a large international open-source community
2. To shares common interests in networks and complex systems
3. To focus on visualization and manipulation, simplicity, and extensibility.
4. To complement the statistical analysis to discover, extract, and classify new patterns in network structure and data.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	To learn about interactive network exploration and visualization accompanied by the graph theory concepts that drive them	Familiarity
CO-2	To understand the nuances of network visualization	Assessment
CO-3	To understand a conceptual, and also an implementation perspective	Assessment
CO-4	Getting Real-world Graph Datasets explores various networks in Gephi	Assessment
CO-5	Exploring Dynamic and Multilevel Graphs focuses on two special kinds of graphs, dynamic graphs, and multilevel graphs	Assessment
CO-6	Exploring Some Useful Gephi Plugins describes several plugins that are extensively used by researchers and developers while working with Gephi	Assessment

List of Experiments:

S No	Topics	Hours
1	**Social Network Analysis Measuring, Mapping, and Modeling Collections of Connections -** The Network Perspective, The Network Analysis Research andPractitioner Landscape, Social Networks in the Era of Abundant Computation, Node-Link Diagrams: Visually MappingSocial Networks	**4**
2	**Getting Started with NodeXL, Layout, Visual Design, and Labeling -** Downloading and Installing NodeXL, Getting Started with NodeXL, Layout: Arranging Vertices in the Graph Pane, Visual Design: Making Network Displays Meaningful	**4**
3	**Calculating and Visualizing Network Metrics -** Kite Network Example, Computing Graph Metrics, Les Misérables Co-Appearance Network	**4**
4	**Preparing Data and Filtering-** Serious Eats Network Example, Filtering to Reduce Clutter and Reveal, Important Features Putting It All	**4**

	Together.	
5	**Clustering and Grouping -** The 2007 Senate Voting Analysis, Les Misérables Character Clusters, Federal Communications Commission (FCC), Lobbying Coalition Network	**4**
6	**Email: The Lifeblood of Modern Communication -** Working with Email Data, leaning email Data in NodeXL, Analyzing Personal Email Networks Creating a Living Org-Chart with an Organizational Email Network	**4**
7	**Twitter** **Conversation, Entertainment, and Information,** **All in One Network!-** The Nuts and Bolts of Twitter, Networks in Twitter Acquiring Data, Discovery with Twitter	**4**
	Total Lab Hours	**28**

Suggested Text Book(s):

- Hansen, D., Shneiderman, B., and Smith, M.A., 2010. Analyzing social media networks with NodeXL: Insights from a connected world. Morgan Kaufmann.Suggested

Reference Book(s):

- Social Analytics: Network and Text Methods with NodeXL and R.1st Edition by Shaila Miranda and Publisher Prospect Press
- Influence and Behavior Analysis in Social Networks and Social MediabyMehmet Kaya, Reda Alhajj, Lecture Notes in Social Networks, Springer International Publishing

Online Resources: -

- **https://www.youtube.com/user/brianbritt87/videos**
- **Marc SmithTutorials: https://www.youtube.com/watch?v=TiTxYSqPBaI&list=PL0FBF4A3DCF40BCE2**

Evaluation Scheme:

S No	Exam	Coverage/Scope of Examination	Marks
1	Mid Term Test	Viva and Written Exam	20
2	End Term Test	Viva and Written Exam	20
3	Lab Records		15
4	Teacher Assessment	(Quality and quantity of experiment performed, learning laboratory skills)	30
5	Attendance and discipline in lab		15
6	Total		100

Course Outcomes (COs) contribution to the Program Outcomes (POs)

Course outcomes	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	3	2	2	3	2	2	2	3	1	3	2.4
CO-2	3	3	3	2	3	2	3	2	2	3	1	3	2.5
CO-3	3	3	3	2	2	3	1	2	3	3	1	3	2.4
CO-4	3	3	3	2	3	3	2	2	3	3	1	3	2.6
CO-5	3	3	3	2	3	3	2	2	3	3	1	3	2.6
CO-6	3	3	3	2	3	3	2	2	1	3	1	3	2.4
Average	3	3	3	2	2.7	2.8	2	2	2.3	3	1	3	

COMPUTER ANIMATION

COURSE CODE: XXX
COURSE CREDITS: 2
CORE/ELECTIVE: ELECTIVE
L-T-P: 2-0-0
Description
This course investigates the theory, algorithms, and techniques for describing and programming motion for animation worlds. Approaches that will be explored include keyframing systems, kinematics, the motion of articulated figures, and procedural and behavioral systems.
Pre-requisite: Computer Graphics, C
Course Objectives: Students will be able

1. To learn the basic of animation
2. To learn the fundamentals of keyframing and interpolation.
3. To understand the working of motion.
4. To understand animating behavior and articulated figures.
5. To learn the basic principles of motion capture and apply them to an animation application.
6. To understand Human figure study through the anatomy

Course Outcomes

S No	Course Outcomes	Level of Attainment
CO-1	Understand the basic of animation	Familiarity
CO-2	Able to learn the fundamentals of keyframing and interpolation.	Assessment
CO-3	Understand the working of motion	Familiarity
CO-4	Demonstrate the skills for animating behavior and articulated figures	Assessment
CO-5	Able to learn the basic principles of motion capture	Assessment
CO-6	To develop animation application and facial recognition	Usage

Course Contents:

Unit	Contents	Lectures Required
1	**Introduction-** Motion perception, Heritage of animation, Animation production, Computer animation production, History of computer animation, **Technical Background-** Spaces and transformations, Orientation representation	**4**
2	**Interpolating Values-** Interpolation, Controlling the motion of a point along a curve, Interpolation of orientations, Working with paths, **Interpolation-Based Animation-** Key-frame systems, Animation	**4**

	languages, Deforming objects, Three-dimensional shape interpolation, Morphing (two-dimensional)	
3	**Kinematic Linkages-** Hierarchical modeling, Forward kinematics, Inverse kinematics, **Motion Capture-** Motion capture technologies, Processing the images, Camera calibration, Three-dimensional position reconstruction, Fitting to the skeleton, Output from motion capture systems, Manipulating motion capture data	**5**
4	**Physically Based Animation**- Basic physic, Spring animation examples, Particle systems, Rigid body simulation, Cloth, Enforcing soft and hard constraints, **Fluids-** Liquids and Gases: Specific fluid models, Computational fluid dynamics	**5**
5	**Modeling and Animating Human Figures**- Overview of virtual human representation, Reaching and grasping, Walking, Coverings, **Facial Animation:** Human face, Facial models, Animating the face, Lip-sync animation	**5**
6	**Behavioral Animation-** Primitive behaviors, Knowledge of Environment, Modeling intelligent behavior, Crowds, **Special Models for Animation-** Implicit surfaces, Plants, Subdivision surfaces	**5**
	Total Lecture Hours	**28**

Text Book

- Computer Animation: Algorithms and Techniques, 3rd Edition, by Rick Parent (Morgan Kauffmann, 2012), ISBN: 0124158420
- **Reference Books**
- Foundations of Physically Based Modeling & Animation by Donald H. House and John C. Keyser CRC Press, 2016, ISBN: 9781482234602
- Physics for Game Developers by David M. Bourg, O'Reilly, 2002, ISBN: 0596000065

Evaluation Scheme:

S No	Exam	Marks	Duration	Coverage/ Scope of Examination
1	T-1	15	1 Hour	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Avg
CO-1	1	1		1	1	1	1	1		1	1		1
CO-2	2	2	2			2		2			2		2
CO-3	3	3	3				3	3					3
CO-4		1	1	1	1			1	1	1	1	1	1
CO-5	3	3		3	3				3	3	3	3	3
CO-6	2		2	2	2	2	2	2	2	2	2	2	2
Avg	2.2	2	2	1.8	1.8	1.7	2	1.8	2	1.8	1.8	2	1.9

COMPUTER ANIMATION LAB

COURSE CODE: XXX
COURSE CREDITS: 1
CORE/ELECTIVE: ELECTIVE
L-T-P: 0-0-2

Description

The students will discover the fundamental principles of animation & exploit these fundamental principles to create convincing character motion.

Course Objectives: Students will be able

1. To learn the basic tool of animation
2. To learn the fundamentals of sketching and drawing.
3. To learn the design of animation character.
4. To develop an animation application

Course Outcomes

S No	Course Outcomes	Level of Attainment
CO-1	Capable to work with basic Animator Drawing Tool	Familiarity
CO-2	Demonstrate the skills for sketching and drawing.	Assessment
CO-3	Capable to develop animation character	Assessment
CO-4	Capable to develop animation application	Usage

List of Experiments

S No	Experiment	Hours
1	**Using Animator's Drawing Tools** The Animation Table (lightbox), Field charts, Line Testing Camera, Peg bar, Punching Machine	**4**
2	**Sketching and Drawing** Drawing for Animation, Exercises and Warm-ups on Pegging Sheet, Quick studies from real life, sequential movement drawing, Caricaturing the action, thumbnails drawing for motion	**8**
3	**Developing an Animation Character** Incorporating various moods and shades of a character Various gestures and facial expressions of the character	**8**
4	**Anatomy and Body Language** Front, side and back view of the character, Anatomy and Body Language of the character Caricaturing the character	**8**
	Total Lab Hours	**28**

Textbook

- The complete animation course by Chris Patmore Pub.-Baron's Educational Series (New York)

Reference book

- Animation Unleashed by Ellen Bessen, Michael Weise Productions Pub.2008 (U.S.A)
- The Animator's Survival Kit by Richard Williams, Arrar Straus & Giroux Pub.(U.S.A)

Evaluation Scheme:

S No	Exam	Coverage/Scope of Examination	Marks
1	Mid Term Test	Viva and Written Exam	20
2	End Term Test	Viva and Written Exam	20
3	Lab Records		15
4	Teacher Assessment	(Quality and quantity of experiment performed, learning laboratory skills)	30
5	Attendance and discipline in lab		15
6	Total		100

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Avg
CO-1	1	1		2	1	3	1	1		2	1		1.4
CO-2	2	1	2			2		2		3	2	1	1.9
CO-3	3	2	3		2		2	3			3		2.6
CO-4		1	2	1	3			1	3	2	1	2	1.8
Avg	2	1.3	2.3	1.5	2	2.5	1.5	1.8	3	2.3	1.8	1.5	2

COURSE CONTENTS
- M.TECH COMPUTER SC. & ENGINEERING WITH SPECIALISATION IN DATA SCIENCE

Advanced Data Structure

COURSE CODE: 10M11CI111

COURSE CREDITS: 3

CORE/ELECTIVE: CORE

L-T-P: 3-0-0

Prerequisites: Data Structures, Algorithms

Course Objective

The field of data structures is similar in spirit to algorithms: what's the fastest way to solve problem X. But data structures take a different tact, focusing on ways to organize a typically long-lived corpus of data so that queries can be answered really fast. A typical example are web search engines, which store sophisticated indexes that support a variety of queries (e.g., what documents contain word X) quickly. In contrast to most algorithmic problems, "linear time" is too slow--you can't afford to scan through the entire web to answer a single query--and the goal is typically logarithmic or even constant time per query. Also, space tends to become a more important issue, because the data corpus is usually big, and you don't really want a data structure that is larger than (or even as big as) the data itself.

Course Outcome (CO)

S No	**Course outcomes (Compiler Design) (**10M11CI213**)**	**Level of Attainment**
CO-1	Student will learn dynamic optimality:(Splay tree, Skip list, tango)	Familiarity
CO-2	Student will learn geometric data structures:(KD tree, Quad Tree, R tree, ray shooting)	Familiarity
CO-3	Student will learn string data structures:(Trie, Compact trie, patricia, suffix tree)	Assessment
CO-4	Student will learn integer data structures: (Binomial heap, fibonacci heap, soft heap)	Usage
CO-5	Student will learn dictionary data structures: (Cuckoo hashing, Bloom filter, Inverted index)	Assessment
CO-6	Student will learn external memory model:(I/O complexity, Lazy update, B tree, Buffer tree)	Usage
CO-7	Student will learn cache-oblivious:(Large matrix multiplication, block tree)	Assessment
CO-8	Student will learn distributed data structures:(DHT, DBST, trees)	Assessment
CO-9	Student will learn stream data structures:(Sampling, sketching, fingerprint, wavelet, histogram)	Usage

Learning Outcome

The students shall deepen the generic skills to design and implement ADTs, non linear data structures and algorithms for a broad-based set of computing problems in various domains.

Course Contents/Lecture Plan

Sr. No	Theory Component	Lecture
1.	**Dynamic optimality**: binary search trees, analytic bounds, splay trees, geometric view, greedy algorithm, independent rectangle, Wilber, and Signed Greedy lower bounds; key-independent optimality; O(lglg*n*)-competitive Tango trees	**6**
2.	**Dictionary data structures**: Cuckoo hashing, Bloom filter, Inverted index	**6**
3.	**String data structures**: suffix tree, suffix array, Inverted index	**3**
	T1	
4.	I**nteger data structures**: Binomial heap, fibonacci heap, soft heap and their applications to MST and shortest path problems	4
5.	**Round-robin MST:** Tarzan's implementation using fibonacci heap and Amortized complexity	**2**
6.	**Succinct data structures:** k-ary tree, multisets, rank/select	**2**
7.	**Geometric data structures**: orthogonal range queries, range trees, interval trees, KD tree, Quad Tree, R tree, ray shooting	**6**
	T2	
8.	**Nearest neighbour search:** approximation and locality sensitive hashing	**2**
9.	**External memory / cache-oblivious**: I/O complexity, Lazy update, B tree, Buffer tree and cache oblivious implementation of Large matrix multiplication and block tree	**4**
10.	**Distributed data structures:** hash table, trees, stack and lists	**5**
11.	**Stream data structures:** synopsis, sketches, histogram, fingerprint, wavelets, sliding windows etc	**4**
	T3	
	Total Lectures	**42**

Schedule : Lectures: 3 hours/week.

Evaluation Components

S.No	Exam	Marks	Duration	Coverage/Scope of Examination
1	Test -1	15	1 hr.	Syllabus covered upto T - 1
2	Test -2	25	1 hr 30 min.	Syllabus covered upto T - 2
3	Test - 3	35	2 hr.	Entire Syllabus
4	Assignments, Quizzes, Attendance	25	Entire Semester	Tutorials / Assignment - 10 Quizzes -10 Attendance - 5.

Teaching Methodology

The course will use the mixed technique of interactive lectures, guided case studies, literature survey, regular assignments and project work. In addition to the material covered in the class, students will be required to explore study, evaluate, present and implement several data structures and their applications. Teaching in this course is designed to engage the students in active and experiential learning by taking a problem solving and design oriented approach with special emphasis on real world applications. Lectures will be highly interactive and work oriented. Students will have to work individually as well as in groups inside as well as outside the class. Students are expected to carry out lot of design and programming oriented project work. Each student is also expected to choose a topic from the list provided. There should be a report component, on the order of 10 pages, let's say in the range 5-20 pages, a code component regarding some dedicated application and they will give a presentation about their project.

Text Book(s) / Reference Book(s)

1) Peter Brass : Advanced Data Structure
2) Jeff Vitter: External Memory Data structures
3) Muthukrishnan: Synopsis data structures

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	Avg
CO1	3	3	2	2	2	2	1	1	2	2	2	2	2
CO2	3	3	2	2	2	1	1	2	2	2	1	2	1.91
CO3	3	3	2	2	2	2	2	1	2	2	1	2	2
CO4	3	3	2	2	3	1	2	2	2	2	1	2	2.08
CO5	3	3	2	2	2	2	3	2	2	2	2	2	2.25
CO6	3	3	2	2	2	3	2	1	2	2	2	2	2.16
CO7	3	3	3	3	3	1	2	2	2	2	1	2	2.08
CO8	3	3	2	2	3	2	2	1	2	2	1	2	2.08
CO9	3	3	3	3	2	1	2	2	2	3	2	2	2.33
Avg	3	3	2.22	2.22	2.33	1.67	1.88	1.55	2	2.11	1.44	2	

Mathematical Foundations for Data Science

COURSE CODE: XXX
COURSE CREDITS: 3
CORE/ELECTIVE:
L-T-P: 3-0-0

Pre-requisite: Knowledge of mathematical concepts in undergraduate level

Course Objectives:

1. To introduce students to the fundamental mathematical concepts of multivariate calculus and linear algebra required for data analysis & machine learning.
2. To provide an understanding for the Data science students on inferential statistical concepts to include sampling, estimation, parametric & non-parametric hypothesis testing, correlation & multiple regression.
3. To extend and familiarize the students with the concepts of Stochastic models with Bayesian inference.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Demonstrate understanding of concepts of multivariable calculus	Familiarity
CO-2	Understand the use of eigenvalues, eigenvectors in Matrix factorizations and vector space concepts.	Assessment
CO-3	Demonstrate proficiency on computing probabilities of discrete and continuous probability distributions and their modeling applications.	Assessment
CO-4	Develop appropriate optimization models for some applications in Data science	Usage

Course Contents:

Unit	Contents	Lectures required
1	Functions of several variables - Directional Derivative and Gradient vectors - Lagrange Multipliers. Matrix factorizations: Singular value decomposition (SVD); Basics of *vector space;* Projections: hyperplanes; Least-Squares problem.	**10**
2	Probability distributions of joint random variables; conditional expectation, covariance and correlation; standard univariate and multivariate distributions. Correlation & linear regression, classification by logistic regression; sampling distributions; Point & interval estimation, maximum likelihood estimation; concept of hypothesis testing: confidence Intervals; tests of significance for comparing two population means and variances. Non-parametric tests: Mann-Whitney test, Kolmogorov-Smirnov test (KS test).	**18**
3	Classification of random processes; Markov chains (discrete & continuous);Bayesian inference: Gibbs Sampling and data augmentation, Metropolis-Hastings independence sampling algorithm; Introduction to Optimization; Unconstrained	**14**

	optimization - Gradient Descent, Conjugate Gradient Descent; Constrained optimization - KKT conditions.	
Total Lectures		**42**

Suggested Text Book(s):

1. G. Strang: ``*Introduction to Linear Algebra"*, Wellesley-Cambridge Press, Fifth edition, USA, 2016.
2. Oliver C. Ibe: ``Fundamentals of applied probability and random processes", Academic press, 2005.
3. Suvrit Sra, Sebastian Nowozin, and Stephen J. Wright: `` *Optimization for machine learning"*,Mit Press, 2012.
4. Douglas C. Montgomery, Elizabeth A. Peck, G. Geoffrey Vining: ``Introduction to Linear Regression Analysis", John Wiley and Sons, Inc. NY, 2003.
5. Sheldon M. Ross, Stochastic Processes, Wiley, 1995.
6. W. R. Gilks, S. Richarson and D. Spiegelhalter, ``Markov chain Monte Carlo methods in Practice", Chapman and Hall, 1996.

Suggested Reference Book(s):

1. S. M. Ross: ``Introduction to Probability Models", Academic Press.
2. David G. Luenberger: ``Optimization by Vector Space Methods", John Wiley & Sons (NY), 1969.
3. Cathy O'Neil and Rachel Schutt: ``Doing Data Science", O'Reilly Media, 2013.
4. Larry A. Wasserman, ``All of Statistics: A Concise Course in Statistical Inference", Springer Texts in Statistics Springer, New York, 2004.
5. Samprit Chatterjee and A. S. Hadi, ``Regression Analysis by Example", 4th Ed., John Wiley and Sons, Inc, 2006.

EvaluationScheme:

S No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes(2) -10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Parallel and Distributed Algorithms)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	
Average													

COURSE CODE: XXX

COURSE CREDITS: 3

CORE/ELECTIVE: CORE

L-T-P: 3-0-0

Pre-requisite: Basic knowledge of high school mathematics and reasonable programming experience.

Course Objectives:

- Asking the correct questions and analyzing the raw data.
- Modelling the data using various complex and efficient algorithms.
- Visualizing the data to get a better perspective.
- Understanding the data to make better decisions and find the final result.
- Basic understanding of python and machine learning algorithms

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	Understanding the basics of data science	Familiarity
CO-2	Using versatile and flexible languages (Python and R programming) for supporting data science	Usage
CO-3	Using data processing for collecting and manipulating the data into the usable and desired form	Usage
CO-4	Using data visualization to easily access the huge amount of data in visuals	Usage
CO-5	Using statistics to collect and analyze the numerical data in a large amount and finding meaningful insights from i	Usage
CO-6	Understanding linear algebra to represent, model, synthesize and summarize the complex data	Usage

Course Contents:

Unit	Contents	Lectures required
1	**Data Science an Introduction:** Computer Science, Data Science, and Real Science, What is Data Science? Need for Data Science, Data Science Components, Tools for Data Science, Data Science Lifecycle, Applications of Data Science.	2
2	**Python and R Programming for Data Science for Data Science:** Introduction to Python Programming (Python Basics,Python Data Structures, Python Programming Fundamentals, Working with Data in Python, Working with NumPy, Pandas, SciPy, and Matplotlib). Introduction to R Programming (R basics, Data structures in R, R Programming fundamentals, Working with Data in R, Stings, and Dates in R, Discover R's packages to do graphics).	5
3	**Data Processing:** Data Operations, Data cleansing, Processing CSV Data, Processing JSON Data, Processing XLS Data, Relational databases, NoSQL Databases, Date and Time, Data Wrangling, Data Aggregation, Reading HTML Pages, Processing Unstructured Data, Word tokenization, Stemming and Lemmatization.	5
4	**Data Visualization:** Chart Properties, Chart Styling, Box Plots, Heat Maps, Scatter Plots, Bubble Charts, 3D Charts, Time Series, Geographical Data, Graph Data	6
5	**Statistical Data Analysis:** Measuring Central Tendency, Measuring Variance, Normal Distribution, Binomial Distribution, Poisson Distribution, Bernoulli Distribution, P-Value, Correlation, Chi-square Test, Linear Regression	8
6	**Supervised and Unsupervised Learning**: Classification and Regression, Generalization, over fitting and under fitting, Supervised Machine learning algorithms, Types of unsupervised learning, preprocessing and scaling, clustering	6
7	**Working with text data**: types of data represented as strings, representing text data as a bag of words, stop words, rescaling, advanced tokenization, stemming and lemmatization	5
	Total lectures	42

Suggested Text Book(s):

- Data Science from Scratchby Joel Grus
- Data Science for Dummiesby Lillian Pierson and Jake Porway
- An Introduction to Statistical Learningby Gareth James, Daniela Witten, et al.
- Introduction to machine learning with python: Andreas C. Muller and Sarah Guido

Suggested Reference Book(s):

- An Introduction to Probability and Statistics by V.K. Rohatgi & A.K. Md. E. Saleh, Wiley, (2008), 3rd ed.
- Introduction to Probability Theory and Statistical Inference by H.J. Larson, John Wiley & Sons, (2005) 3rd ed.

Other useful resource(s):

- https://nptel.ac.in/courses/110/106/11010604/
- https://onlinecourses.nptel.ac.in/noc18_cs28/preview

EvaluationScheme:

S No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes(2) -10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Foundation for Data Science and Visualization)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	3	2	1	1	1	3	2	2	1	1.8
CO-2	3	3	3	3	3	1	1	2	2	2	1	1	2.1
CO-3	2	2	2	2	1	1	2	2	2	2	1	2	1.8
CO-4	3	3	3	3	2	1	1	3	2	3	3	2	2.4
CO-5	3	2	3	3	1	1	2	1	1	3	2	1	1.9
CO-6	2	2	1	2	2	2	3	2	1	2	3	1	1.9
Average	2.5	2.3	2.3	2.7	1.8	1.2	1.7	1.8	1.8	2.3	2	1.3	2.0

Advanced Data Structure Lab

COURSE CODE: XXX

COURSE CREDITS: 1

CORE/ELECTIVE: CORE

L-T-P: 0-0-2

Pre-requisites: None

Course Objectives:

1. Develop problem solving ability using Programming
2. Develop ability to design and analyze algorithms
3. Introduce students to data abstraction and advanced data structures
4. Develop ability to design and evaluate advanced data structures
5. Apply advanced data structure concepts to various examples and real life applications

Course outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	Understanding Dictionary data structures	Familiarity
CO-2	Student will learn string data structures:(Trie, Compact trie, patricia, suffix tree)	Usage
CO-3	Student will learn Integer data structures	Assessment
CO-4	Student will learnDistributed data structures: hash table, trees, stack and lists.	Assessment
CO-5	Student will learn Stream data structures:synopsis, sketches, histogram, fingerprint, wavelets, sliding windows etc	Usage
CO-6	Student will learn Geometric data structures: orthogonal range queries, range trees, interval trees, KD tree, Quad Tree, R tree, ray shooting	Usage

List of Experiments:

S No	Description	Hours
1	Implement the Dictionary data structures	2
2	Implement thestring data structures: Trie, Compact trie, patricia, suffix tree	4
3	Implement Binomial heap	2
4	Implement insertion, deletion and display operations in Binary Search Trees	2
5	Implement insertion, deletion and display operations in Red Black Trees	2

6	Implement insertion, deletion and display operations in B-Trees	2
7	Implement Huffman Coding Algorithm.	4
8	Implement Distributed data structures: hash table, trees, stack and lists.	4
9	Implement string matching algorithm.	2
10	Implement Quad trees	4
		28

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Attendance	15 Marks
4	Lab Assessment	45 Marks
	Total	100 marks

Suggested Books/Resources:

1. Peter Brass : Advanced Data Structure
2. Jeff Vitter: External Memory Data structures
3. Muthukrishnan: Synopsis data structures
4. Corman et al : Introduction to Algorithms, 3rd Edn., 2009
5. http://www.nptel.iitm.ac.in/video.php?subjectId=106102064, last accessed Mar 13, 2014.
6. http://www.cs.auckland.ac.nz/~jmor159/PLDS210/ds_ToC.html, last accessed Mar 13, 2014.
7. http://courses.cs.vt.edu/csonline/DataStructures/Lessons/index.html, last accessed Mar 13, 2014.
8. Link to topics related to course:
    a. http://cse.iitkgp.ac.in/~pallab/pds16/pds16.htm
    b. https://onlinecourses.nptel.ac.in/programming101/preview

Course Outcomes (COs) contribution to the ProgrammeOutcomes(POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Average
CO-1	3	2	3	2	2	3	3	3	2	3	2	2	2.5
CO-2	3	3	3	2	3	3	3	3	2	3	2	3	2.8
CO-3	3	3	3	2	2	3	3	3	3	3	2	2	2.7
CO-4	3	3	3	3	3	3	3	2	2	3	3	3	2.8
CO-5	3	3	3	2	2	2	3	3	3	3	2	2	2.6
CO-6	3	3	3	3	3	3	3	2	2	3	3	3	2.8
Average	3	2.83	3	2.33	2.5	2.83	3	2.67	2.6	3	2.33	3	

COURSE CODE: XXX

COURSE CREDITS: 02

CORE/ELECTIVE: CORE

L-T-P: 2-0-0

Pre-requisite: Python/ R Programming and Machine Learning

Course Objectives:

- Asking the correct questions and analyzing the raw data.
- Modelling the data using various complex and efficient algorithms.
- Visualizing the data to get a better perspective.
- Understanding the data to make better decisions and find the final result.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	Understanding the basics of data science	Familiarity
CO-2	Using versatile and flexible languages (Python and R programming) for supporting data science	Usage
CO-3	Using data processing for collecting and manipulating the data into a usable and desired form	Usage
CO-4	Using statistics to collect and analyze the numerical data in a large amount and finding meaningful insights from i	Usage
CO-5	Understanding linear algebra to represent, model, synthesize and summarize the complex data	Usage
CO-6	Using data visualization to easily access the huge amount of data in visuals	Usage

List of Experiments

S No	Description	Hours
1	• Write a Python/R program to create a vector of a specified type and length. Create a vector of numeric, complex, logical, and character types of length 6. • Write a Python/R program to add two vectors of integer type and length 3. • Write a Python/R program to create a list containing a vector, a matrix, and a list and remove the second element	**03**

	• Write a Python/R program to create a list containing a vector, a matrix, and a list and update the last element.	
2	Write Python/R programs to solve the following tasks in both of them. • Read numbers from a file, and print them out in sorted order. • Read a text file, and count the total number of words. • Read a text file, and count the total number of distinct words. Read a file of numbers, and plot a frequency histogram of them	**03**
3	**Statistical Data Analysis:** Measuring Central Tendency**,** Measuring Variance**,** Normal Distribution**,** Binomial Distribution**,** Poisson Distribution**,** Bernoulli Distribution**,** P-Value**,** Correlation**,** Chi-square Test**,** Linear Regression	**03**
4	**Data Visualization** Construct a revealing visualization of some aspect of your favorite data set, using: • A well-designed table. • A dot and/or line plot. • A scatter plot. • A heatmap. • A bar plot or pie chart. • A histogram. • A data map.	**03**
5	**Data Visualization** Create ten different versions of line charts for a particular set of (x, y) points. Which ones are best and which ones worst? Explain why	**02**
6	**Data Visualization** Construct scatter plots for sets of 10, 100, 1000, and 10,000 points. Experiment with the point size to find the most revealing value for each data set	**02**
7	**Supervised Learning** K-Nearest Neighbors, Linear models, Naïve Bayes classifiers, Decision trees, Neural Networks	**03**
8	**Unsupervised Learning** Principal component analysis, Non-negative matrix factorization, K-means clustering, Agglomerative clustering, Comparison and evaluating clustering algorithms	**03**
9	**Working with text data** Rescaling data with tf-idf, topic modeling and document clustering	**02**
10	**Wrapping up:** Approaching a machine learning problem, Testing production systems, machine learning frameworks and packages, probabilistic programming, neural networks, scaling to larger datasets	**04**
Total Lab hours		**28**

Suggested Text Books:

- Python Data Science Hand Book JakeVanderPlas
- Introduction to machine learning with python: Andreas C. Miller and Sarah Guido
- Mastering Python for Data Science - by Samir Madhavan.
- R Programming for Data Science by Roger D. Peng

Reference Books:

- Python Data Science: Hands-on Learning for Beginners Kindle Editionby Travis Booth (Author)
- Data Science with R: A Step By Step Guide with Visual Illustrations & Examples by Andrew Oleksy
- R for Data Science: Import, Tidy, Transform, Visualize, and Model Data by Hadley Wickham (Author), Garrett Grolemund

EvaluationScheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Project-1	10 Marks
4	Lab Assessment	45 Marks
5	Lab Attendance	5 Marks
	Total	100 marks

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Data Science and Visualization Lab)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	3	2	1	1	1	3	2	2	1	1.8
CO-2	3	3	3	3	3	1	1	2	2	2	1	1	2.1
CO-3	2	2	2	2	1	1	2	2	2	2	1	2	1.8
CO-4	3	3	3	3	2	1	1	3	2	3	3	2	2.4
CO-5	3	2	3	3	1	1	2	1	1	3	2	1	1.9
CO-6	2	2	1	2	2	2	3	2	1	2	3	1	1.9
Average	2.5	2.3	2.3	2.7	1.8	1.2	1.7	1.8	1.8	2.3	2	1.3	2.0

Mathematical Foundations for Data ScienceLab

COURSE CODE: XXX
COURSE CREDITS: 2
CORE/ ELECTIVE: Elective
L-T-P: 0-0-2

Pre-requisite: Mathematical Foundations for Data Science (Theory)

Course Objectives:

4. To introduce students to the fundamental mathematical concepts of multivariate calculus and linear algebra required for data analysis & machine learning.
5. To provide an understanding for the Data science students on inferential statistical concepts to include sampling, estimation, parametric & non-parametric hypothesis testing, correlation & multiple regression.
6. To extend and familiarize the students with the concepts of Stochastic models with Bayesian inference.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Understand the theoretical concepts of calculus of several variables.	Familiarity
CO-2	Understand the concept of matrix factorization and notion of vector space and their applications.	Assessment & Usage
CO-3	Understand random variables and their distributions in modeling random phenomenon	Assessment & Usage
CO-4	Understand and solve min/max problems of constrained optimization.	Assessment & Usage

List of Experiments

S. No.	Description	Hours
1	Find the gradient and Hessian for the given function of several variables. Determine the extrema of an unbounded f(x, y). Are the point(s) you have found maxima, minima, or saddle points?	2
2	Compute calculations of singular-value decomposition.	2
3	Generate two vectors x and y of n independent N(0,1) random variables. Illustrate their joint probability distribution through graph: y versus x	2
4	Generate a NxK matrix X, with K = 256 realizations of the stochastic process x[n], n = 1, 2, . . . , N. For a given value of N, and let each x[n] be N(0,1). Plot the ensemble average.	2
5	Write a program to demonstrate *Binomial* for the given parameters.	2
6	Generate n random variables from N(0,1) and U(0,1) distributions respectively. Plot the histograms.	2

7	Calculate regression coefficients and the equation of regression line for the given data.	
8	Simulate the *distribution of the mean* for specified distribution – normal; obtain the parameters; Display histogram.	2
9	From the frequency distribution table for a given date, write a program to calculate mean and standard deviation.	2
10	Hypothesis testing for two population means for the given data.	2
11	Non-parametric test: Kolmogorov-Smirnov normality test.	2
12	Implement the conjugate gradient descent algorithm for the given problem.	2
13	Obtain a Bayesian estimate of the mean and variance of the given data and compare it to the MLE.	
14	Write a code to solve the given constrained optimization problem with inequality Constraints.	2
	Total Lab hours	**28**

Suggested Resources:

6. Marc Peter Deisenroth, A. Aldo Faisal, Cheng Soon Ong, ``Mathematics for Machine Learning,'' Cambridge University Press, 2019.
7. Steven J. Leon and Lisette de Pillis, ``Linear Algebra with Applications,'' Pearson, 10th ed, 2019.
8. Gene H. Golub and Charles F. Van Loan, Matrix Computations, The Johns Hopkins University Press, Baltimore, 4th Ed., 2013.
9. Andreas Antoniou, Wu-Sheng Lu, ``Practical Optimization: Algorithms and Engineering Applications,'' Springer US, 2021.
10. S. L. Miller and D. G. Childers, Probability and Random Processes With Applications to Signal Processing and Communications. Elsevier Academic Press, Burlington, MA, 2004.
11. Douglas C. Montgomery, Elizabeth A. Peck, G. Geoffrey Vining: ``Introduction to Linear Regression Analysis'', John Wiley and Sons, Inc. NY, 2003.
12. W. R. Gilks, S. Richarson and D. Spiegelhalter, ``Markov chain Monte Carlo methods in Practice'', Chapman and Hall, 1996.

EvaluationScheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Attendance	15 Marks
4	Lab Assessment	45 Marks
	Total	100 marks

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	Averag e
CO1	3	3	3	3	2	2	1	1	1	1	1	1	**1.83**
CO2	3	3	3	3	3	1	1	1	1	1	1	3	**2.00**
CO3	3	3	2	3	2	3	2	1	1	1	2	1	**2.00**
CO4	3	3	3	2	3	2	1	1	1	1	1	1	**1.83**
CO5	2	2	3	3	3	3	1	1	1	1	1	1	**1.83**
C06	2	3	3	3	2	2	2	2	2	2	2	2	**2.25**
Averag e	**2.67**	**2.83**	**2.80**	**2.80**	**2.60**	**2.20**	**1.20**	**1.00**	**1.00**	**1.00**	**1.20**	**1.40**	

COURSE CODE: XXX

COURSE CREDITS: 3

CORE/ELECTIVE: CORE

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

7. Understanding basics of soft computing.
8. Learning fuzzy logic.
9. Learning neural networks.
10. Learning genetic algorithms.
11. Applying fuzzy logic, neural networks and genetic algorithm.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	Basics of soft computing and understanding fuzzy logic.	Familiarity
CO-2	Learn and analyze neural networks.	Assessment
CO-3	Learn and analyze genetic algorithms.	Assessment
CO-4	Apply important algorithmic design paradigms and method soft computing.	Usage

Course Contents:

Unit	Contents	Lectures required
1	Introduction to Soft Computing and Neural Networks: Evolution of Computing: Soft Computing Constituents, From Conventional AI to Computational Intelligence: Machine Learning Basics	**6**
2	Fuzzy Logic: Fuzzy Sets, Operations on Fuzzy Sets, Fuzzy Relations, Membership Functions: Fuzzy Rules and Fuzzy Reasoning, Fuzzy Inference Systems, Fuzzy Expert Systems, Fuzzy Decision Making	**8**
3	Neural Networks: Machine Learning Using Neural Network, Adaptive Networks, Feed forward Networks, Supervised Learning Neural Networks, Radial Basis Function Networks: Reinforcement Learning, Unsupervised Learning Neural Networks, Adaptive Resonance architectures, Advances in Neural networks	**10**

4	Genetic Algorithms: Introduction to Genetic Algorithms (GA), Applications of GA in Machine Learning: Machine Learning Approach to Knowledge Acquisition.	**5**
5	Matlab/Python Lib: Introduction to Matlab/Python, Arrays and array operations, Functions and Files, Study of neural network toolbox and fuzzy logic toolbox, Simple implementation of Artificial Neural Network and Fuzzy Logic Recent Trands in deep learning, various classifiers, neural networks and genetic algorithm. Implementation of recently proposed soft computing techniques.	**13**
	Total lectures	**42**

EvaluationScheme:

S No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes(2) -10 Attendance – 5

1. Textbook(s): 1. Jyh:Shing Roger Jang, Chuen, Tsai Sun, EijiMizutani, Neuro: Fuzzy and Soft Computing, Prentice Hall of India, 2003.
2. References 1. George J. Klir, Bo Yuan, Fuzzy Sets and Fuzzy Logic: Theory and Applications, Prentice Hall, 1995.

Course Outcomes (COs) contribution to the ProgrammeOutcomes(POs)

Course outcomes	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	**1.9**
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	**2**
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	**1.9**
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	**2.1**
Average	**2**	**2.5**	**2.5**	**2.5**	**2.5**	**1**	**1**	**1**	**2**	**2.2**	**1.5**	**2**	

Deep Learning Techniques

COURSE CODE: XXX

COURSE CREDITS: 3

CORE/ELECTIVE: CORE

L-T-P: 0-0-3

Pre-requisite: None

Course Objectives:

1. understand complexity of Deep Learning algorithms and their limitations
2. understand modern notions in data analysis oriented computing;
3. be capable of confidently applying common Deep Learning algorithms in practice
4. and implementing their own;
5. be capable of performing distributed computations;
6. be capable of performing experiments in Deep Learning using real-world data.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	Understand the concepts of TensorFlow, its main functions, operations and the execution pipeline	Familiarity
CO-2	Implement deep learning algorithms, understand neural networks and traverse the layers of data abstraction which will empower the student to understand data more precisely	Assessment
CO-3	Learn topics such as convolutional neural networks, recurrent neural networks, training deep networks and high-level interfaces	Assessment
CO-4	Understand the language and fundamental concepts of artificial neural networks	Usage

Course Contents:

Unit	Contents	Lectures required
1	**Introduction to TensorFlow:** Computational Graph, Key highlights, Creating a Graph, Regression example, Gradient Descent, TensorBoard, Modularity, Sharing Variables, Keras**Perceptrons**: What is a Perceptron, XOR Gate	8
2	**Activation Functions :**Sigmoid,ReLU, Hyperbolic Fns,Softmax **Artificial Neural Networks** : Introduction, Perceptron Training Rule, Gradient Descent Rule	8
3	**Gradient Descent and Backpropagation**: Gradient Descent, Stochastic Gradient Descent, Backpropagation, Some problems in	8

	ANN **Optimization and Regularization** :Overfitting and Capacity, Cross Validation, Feature Selection, Regularization, Hyperparameters	
4	**Introduction to Convolutional Neural Networks**: Introduction to CNNs, Kernel filter, Principles behind CNNs, Multiple Filters, CNN applications **Introduction to Recurrent Neural Networks**: Introduction to RNNs, Unfolded RNNs, Seq2Seq RNNs, LSTM, RNN applications	**10**
5	**Deep Learning applications**: Image Processing, Natural Language Processing, Speech Recognition, Video Analytics	**8**
	Total lectures	**42**

Suggested Text Book(s):

1. Goodfellow, I., Bengio,Y., and Courville, A., Deep Learning, MIT Press, 2016.

Suggested Reference Book(s):

2. 1. Bishop, C. ,M., Pattern Recognition and Machine Learning, Springer, 2006.
3. 2. Yegnanarayana, B., Artificial Neural Networks PHI Learning Pvt. Ltd, 2009.
4. 3. Golub, G.,H., and Van Loan,C.,F., Matrix Computations, JHU Press,2013.
5. 4. Satish Kumar, Neural Networks: A Classroom Approach, Tata McGraw-Hill Education,
6. 2004

Other useful resource(s):

1. https://nptel.ac.in/courses/106/106/106106184/
2. https://cse.iitkgp.ac.in/~adas/courses/dl_spr2020/syllabus.html
3. https://www.edx.org/learn/deep-learning
4. http://introtodeeplearning.com/

EvaluationScheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes(2) -10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	**1.8**
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	**2**
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	**1.8**
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	**2.1**
Average	**2**	**2.5**	**2.5**	**2.5**	**2.5**	**1**	**1**	**1**	**2**	**2.3**	**1.5**	**2**	**1.9**

COURSE CODE: 15B1WCI833
COURSE CREDITS: 3
CORE/ELECTIVE: ELECTIVE
L-T-P: 3-0-0

Introduction

This course introduces basic technology (algorithms, architectures, systems) and advanced research topics in connection with large-scale data management and information extraction techniques for big data. The course will start by introducing the fundamentals of Big data and cover modern distributed database systems and algorithms and Big data systems adopted in industry and science applications. Distributed storage and parallel processing and architectures that support data analytics will be examined, and students will learn how to implement a distributed data processing system. The course will also cover critical topics in mining and knowledge discovery of big data, with applications in social analytics, cyber security, and information networks, among others that are already in public eye.

Course Objectives (Post-conditions)

Knowledge objectives:

1. Understand the need for Bid Data Analytics
2. Master the concepts of large scale file systems and map reduce framework
3. Master the concepts of mining data streams
4. Master the concepts of Link analysis and frequent item sets discovery from Big data
5. Master the concepts of clustering for streams and parallelism.

Application objectives:

1. Understand and apply the Big Data Analysis techniques to real world problems including social analytics, cyber security, and information networks, among others that are already in public eye.
2. Being able to describe and apply the Data Analytics lifecycle to Big Data projects including set up of smart cities.

Expected Student Background (Preconditions)

1. Good knowledge of Statistics
2. Working knowledge of databases
3. Good knowledge of data structures and algorithms

Topics Outline:

Serial Number	Topics	Hours
1	Introduction to Big Data: Big data time line, Why this topic is relevant now? Is big data fad? Where using big data makes a difference? Introduction to statistical modeling and machine learning, Ordinary data processing versus big data processing: Challenges and opportunities	3
2	Map Reduce and the New Software Stack: Distributed File Systems, Map Reduce, Algorithms Using Map Reduce, Complexity Theory for Map Reduce	3
3	Mining Data Streams: The Stream Data Model, Sampling Data in a	5

	Stream, Filtering Streams, Counting Distinct Elements in a Stream, Estimating Moments and Windowing, Decaying Windows	
4	Link Analysis: Page Rank and Efficient Computation of Page Rank, Topic-Sensitive Page Rank, Link Spam, Hubs and Authorities	5
5	Frequent Item sets from Big Data: The Market-Basket Model, Market Baskets and the A-Priori Algorithm, Handling Larger Datasets in Main Memory, Limited-Pass Algorithms, Counting Frequent Items in a Stream	7
6	Clustering for Big Data: Introduction to Clustering Techniques, Hierarchical Clustering, Clustering in Non-Euclidean Spaces, Clustering for Streams and Parallelism	8
7	Mining Social Network Graphs: Social Networks as Graphs, Clustering of Social-Network Graphs, Direct Discovery of Communities, Partitioning of Graphs, Finding Overlapping Communities, Neighborhood Properties of Graphs	6
8	Recommendation Systems: A Model for Recommendation Systems, Content-Based Recommendations, Collaborative Filtering and Dimensionality Reduction	5
	Total Lectures	42

References

1. Anand Rajaraman and Jeffery David Ullman, Mining of Massive Datasets, Cambridge University Press, 2012
2. Jared Dean, Big Data, Data Mining and Machine Learning, Wiley Big data Series, 2014
3. Judith Hurwitz, Alan Nugent, Fern Halper and Marica Kaufman, Big Data for Dummies, Wiley Press, 2013

Evaluation Scheme:

S No	Examination	Marks
1	T1	15
2	T2	25
3	T3	35
4	* Internal Marks	25

*Internal Marks Breakdown:
Assignments 9 marks (3x3)
Quizzes 12 marks (3x4)
Regularity 4 Marks

Soft Computing Lab

COURSE CODE: XXX

COURSE CREDITS: 1

CORE/ELECTIVE: CORE

L-T-P: 0-0-1

P**re-requisite:** Basic concepts of Programming

Course Objectives:

1. Understanding basics of soft computing.
2. Learning fuzzy logic.
3. Learning neural networks.
4. Learning genetic algorithms.
5. Applying fuzzy logic, neural networks and genetic algorithm.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	Basics of soft computing and understanding fuzzy logic.	Familiarity
CO-2	Learn and analyze neural networks.	Assessment
CO-3	Learn and analyze genetic algorithms.	Assessment
CO-4	Apply important algorithmic design paradigms and method soft computing.	Usage

List of Experiments

S No	Description	Hours
1	Understanding Tensor flow	**2**
2	Understanding keras	**2**
3	Implement Union, Intersection, complement and difference operations on Fuzzy sets.	**2**
4	Create Fuzzy relation by Cartesian product of any two Fuzzy sets and perform Max- Min composition of any two Fuzzy re	**2**
5	Build Logistic Regression Classifier using Neural Networks	**2**
6	Build Deep neural network for classification	**2**
7	Build neural network for Regression	**2**
8	Build a classification model using different parameter initialization techniques.	**2**
9	Build classification model using Mini Batch gradient and Stochastic Gradient techniques.	**4**

10	Implement Genetic algorithm.	**4**
	Total Lab hours	**24**

Suggested/Resources:

3. Textbook(s): 1. Jyh:Shing Roger Jang, Chuen, Tsai Sun, EijiMizutani, Neuro: Fuzzy and Soft Computing, Prentice Hall of India, 2003.
4. References 1. George J. Klir, Bo Yuan, Fuzzy Sets and Fuzzy Logic: Theory and Applications, Prentice Hall, 1995.

EvaluationScheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Attendance	15 Marks
4	Lab Assessment	45 Marks
	Total	100 marks

Course Outcomes (COs) contribution to the ProgrammeOutcomes(POs)

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	Averag e
CO1	3	3	3	3	2	2	1	1	1	1	1	1	**1.83**
CO2	3	3	3	3	3	1	1	1	1	1	1	3	**2.00**
CO3	3	3	2	3	2	3	2	1	1	1	2	1	**2.00**
CO4	3	3	3	2	3	2	1	1	1	1	1	1	**1.83**
Averag e	**2.67**	**2.83**	**2.80**	**2.80**	**2.60**	**2.20**	**1.20**	**1.00**	**1.00**	**1.00**	**1.20**	**1.40**	

Deep Learning Techniques Lab

COURSE CODE: XXX

COURSE CREDITS: 2

CORE/ELECTIVE: CORE

L-T-P: 0-0-2

Pre-requisite: None

Course Objectives:

1. Apply knowledge of mathematics, science, and engineering fundamentals to solveproblems in Computer science and Engineering.
2. Identify, formulate and analyze complex problems.
3. Design system components or processes to meet the desired needs within realisticconstraints for the public health and safety, cultural, societal and environmentalconsiderations.
4. Use research-based knowledge and research methods including design of experiments,analysis and interpretation of data for valid conclusions.
5. Select and apply modern engineering tools to solve the complex engineering problem.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO1	Understand the characteristics and types of artificial neural network and remember working of biologicalNeuron and Artificial Neural Network.	Familiarity
CO2	Apply learning algorithms on perceptron and apply back propagation learning on Neural Network.	Assessment
CO3	Apply Feedback NN and plot a Boltzmann machine and associative memory on various application	Assessment
CO4	Apply different types of auto encoders with dimensionality reduction and regularization.	Assessment
CO5	Design Convolutional Neural Network and classification using Convolutional Neural Network.	Usage
CO6	Solve sequence learning problem and implement long short term memory and gated recurrent units	Usage

List of Experiments

S No	Description	Hours
1	To Write a program to implement Perceptron.	**2**
2	To write a program to implement AND OR gates using Perceptron.	**2**
3	To implement Crab Classification using pattern net	**2**
4	Write a program to implement classification of linearly separable Data with a perceptron	**2**
5	To study Long Short Term Memory for Time Series Prediction	**2**
6	To study Convolutional Neural Network and Recurrent Neural Network	**2**
7	To study ImageNet, GoogleNet, ResNet convolutional Neural Networks	**2**
8	To study the use of Long Short Term Memory / Gated Recurrent Units to predict the stock prices based on historic data	**2**
9	Recurrent Neural Networks	**2**
10	Deep Generative Models	**2**
11	Linear Regression and Logistic Regression	**2**
12	Decision Tree	**2**
13	SVM (Support Vector Machine)	**2**
14	Naive Bayes	**2**
15	kNN (k- Nearest Neighbors)	**2**
16	K-Means	**2**
17	Random Forest	**2**
18	Gradient Boosting Algorithms	**2**
	Total Lab hours	**36**

Suggested Text Book(s):

1. Goodfellow, I., Bengio,Y., and Courville, A., Deep Learning, MIT Press, 2016.

Suggested Reference Book(s):

2. 1. Bishop, C. ,M., Pattern Recognition and Machine Learning, Springer, 2006.
3. 2. Yegnanarayana, B., Artificial Neural Networks PHI Learning Pvt. Ltd, 2009.
4. 3. Golub, G.,H., and Van Loan,C.,F., Matrix Computations, JHU Press,2013.
5. 4. Satish Kumar, Neural Networks: A Classroom Approach, Tata McGraw-Hill Education,
6. 2004

Other useful resource(s):

1. https://nptel.ac.in/courses/106/106/106106184/
2. https://cse.iitkgp.ac.in/~adas/courses/dl_spr2020/syllabus.html
3. https://www.edx.org/learn/deep-learning

4. http://introtodeeplearning.com/

EvaluationScheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Attendance	15 Marks
4	Lab Assessment	45 Marks
	Total	100 marks

Course Outcomes (COs) contribution to the ProgrammeOutcomes(POs)

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	Average
CO1	3	3	3	3	2	2	1	1	1	1	1	1	**1.83**
CO2	3	3	3	3	3	1	1	1	1	1	1	3	**2.00**
CO3	3	3	2	3	2	3	2	1	1	1	2	1	**2.00**
CO4	3	3	3	2	3	2	1	1	1	1	1	1	**1.83**
CO5	2	2	3	3	3	3	1	1	1	1	1	1	**1.83**
CO6	2	3	3	3	2	2	2	2	2	2	2	2	**2.25**
Average	**2.67**	**2.83**	**2.80**	**2.80**	**2.60**	**2.20**	**1.20**	**1.00**	**1.00**	**1.00**	**1.20**	**1.40**	

Big Data using Hadoop Lab

COURSE CODE: XXX
COURSE CREDITS: 1
CORE/ELECTIVE: ELECTIVE
L-T-P: 0-0-2

Pre-requisites: An understanding in practicalities of big data and Hadooptoanyprogramminglanguage(Preferably,C)

Course Objective

The lab course provides a complete description ofthe inner working of big data and Hadoop. The main focus is on the design of big data techniques. The course also aims to convey the language specifications, use of file management tasks, and map-reduce behind the design of algorithms. It builds an understanding of various techniques like map-reduce, pig Latin scripts, etc.

Course Outcomes (COs):

S No	Course outcomes	Level of Attainment
CO-1	Perform setting up and Installing Hadoop in various operating modes	Familiarity
CO-2	Implement file management tasks in Hadoop	Familiarity
CO-3	Running a Map-Reduce Paradigm	Computational skills
CO-4	Run Pig then write Pig Latin scripts	Technical skills

List of Experiments

S No	Topic	Hours
1	Implement the following data structures in Java: Linked list, stacks, queues, Set and Map	**2**
2	Perform setting up and Installing Hadoop in its three operating modes: Standalone, Pseudo distributed, Fully distributed Use web-based tools to monitor your Hadoop setup.	**4**
3	Implement the following file management tasks in Hadoop: • Adding files and directories • Retrieving files • Deleting files Hint: A typical Hadoop workflow creates data files (such as log files) elsewhere and copies them into HDFS using one of the above command-line utilities.	**4**
4	Run a basic Word Count Map Reduce program to understand Map Reduce Paradigm	**4**
5	Write a Map Reduce program that mines weather data. Weather sensors collecting data every hour at many locations across	**4**

	the globe gather a large volume of log data, which is a good candidate for analysis with Map Reduce since it is semi-structured and record-oriented	
6	Implement Matrix Multiplication with Hadoop Map Reduce	**2**
7	Install and Run Pig then write Pig Latin scripts to sort, group, join, project, and filter your data	**4**
8	Install and Run Hive then use Hive to create, alter, and drop databases, tables, views, functions, and indexes	**4**
	Total Lab Hours	**28**

Evaluation Scheme

S No	Exam	Coverage/Scope of Examination	Marks
1	Mid Term Test	Viva and Written Exam	20
2	End Term Test	Viva and Written Exam	20
3	Lab Records		15
4	Teacher Assessment	(Quality and quantity of experiment performed, learning laboratory skills)	30
5	Attendance and Participation in lab		9+6=15
	Total		**100**

Reference Books:

- Jain, Vinay Kumar. Big Data and Hadoop. Khanna Publishing, 2017.

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	2	2	2	1	3	3	2	1	3	2	1	2.1
CO-2	3	3	2	2	1	3	3	1	3	3	3	1	2.3
CO-3	3	3	2	2	2	2	2	1	2	3	3	2	2.3
CO-4	3	3	3	2	2	2	3	2	2	1	2	2	2.3
CO-5	3	3	2	1	1	3	3	1	3	3	3	1	2.3
Average	3	2.8	2.2	1.8	1.4	2.6	2.8	1.4	2.2	2.6	2.6	1.4	2.2

Elective Courses

Advanced Mobile and Distributed Computing

COURSE CODE: 18M1WCI115

COURSE CREDITS: 03

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite Course: Students are expected to have a solid grasp of the fundamentals of computer system including a basic understanding of the operation of the computer, especially CPU.

Course Objectives (Post-conditions)

Knowledge objectives:

1. It focuses on leading system architecture, high speed interconnects, and programming models that have been used for parallel and distributed computing environments.
2. This course will cover fundamental principles, advanced algorithms, and engineering tradeoffs in building large-scale parallel and distributed computing systems, as well as the high speed interconnects that bring them all together.
3. Students will gain an in-depth understanding of research and development in HPC, and their impact on computational sciences.

Application objectives:

1. Grasp a thorough understanding on the advances of technologies, system architecture and communication architecture that propelled the growth of parallel and distributed computing systems
2. 2 Accomplish a good understanding of principles and practices in high speed interconnects
3. Gain an appreciation on the challenges and opportunities faced by parallel systems, and cloud computing environments

Course Outcomes:

S No	Course outcomes	Level of Attainment
CO-1	You will Understand Hardware Architecture - Symmetric Multiprocessing , Distributed Shared Memory, Multicomputers	Familiarity
CO-2	You will Understand Software Architecture - Client server architecture , 3-tier architecture , N-tier architecture, Peer-to-peer	Familiarity
CO-3	Cluster computing	Familiarity

CO-4	Grid computing	Familiarity
CO-5	Virtualisation and Cloud Computing	Technical skills
CO-6	Recent trends in processor technologies - Superscalar processors, Multi-core processors, Embedded processors	Familiarity

Course Contents / Lecture Plan:

S No	Topic	Hrs
1	Hardware Architecture - Symmetric Multiprocessing , Distributed Shared Memory, Multicomputers	7
2	Software Architecture - Client server architecture , 3-tier architecture , N-tier architecture, Peer-to-peer	7
3	Cluster computing	7
4	Grid computing	7
5	Virtualisation and Cloud Computing	7
6	Recent trends in processor technologies - Superscalar processors, Multi-core processors, Embedded processors	7
	Total	42

Evaluation Scheme:

S.No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Assignments, Quizzes, and Attendance	25	Entire Semester	Assignment (3) - 10 Quizzes (2) - 10 Attendance - 5

Text Book(s):

1. Distributed Systems : Concepts and Design - George Coulouris, Jean Dollimore, and Tim Kindberg. 2. Introduction to Reliable Distributed Programming - Rachid Guerraoui and Louis Rodrigues, Springer-Verlag, Berlin, Germany, 2006. 3. Distributed Systems: Principles and Paradigms - Andrew Tanenbaum and Maarten

Reference Book(s)

A. Research Papers

Course Material:

Lecture presentations and assignments will be posted on the student resource from time to time.

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

S No	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Weightage
CO-1	H	M	M	H	M	H	H	H	L	H	M	M	81%
CO-2	H	H	H	M	L	H	H	H	M	H	M	M	83%
CO-3	H	H	H	L	M	H	M	H	M	H	M	H	83%
CO-4	H	H	H	M	M	M	H	M	M	M	H	H	83%
CO-5	H	H	H	M	M	M	M	M	L	M	M	H	75%
CO-6	H	H	H	H	M	H	H	M	M	H	H	M	89%
	100%	96%	96%	78%	63%	89%	93%	85%	59%	81%	85%	85%	

Artificial Intelligence Techniques

Introduction

The course introducesthe students with a number of modernmeta-heuristic techniques

taken fromthe area ofnaturalcomputation for solvinghard optimization problems.The student will be encouraged to solve real world optimization problems using the learnttechniquesand todo a guidedresearch onmethodological issues ofthe techniques. Topicsare likelytobe drawn fromthe following list: planning, scheduling, games, search,reasoning (constraint- based, model-based,spatial,temporal), knowledge representation, decision-making under uncertainty,reinforcement learning,agents, and foundations.

Knowledgeobjectives:

1. Gain botha wide anda deep knowledge oftheTopics(s) taught in the currentinstance of the course.
2. Improve their skills atnavigating through, andcriticallyexamining, the scientific literature on the taught Topics(s).

Applicationobjectives:

The coursewill teach you to apply the basic principles, models, and algorithms of AI to recognize, model, and solve problems in the analysisand design ofinformation systems. Through home assignments you will be able to analyzethe structures andalgorithms ofa selection oftechniques related to searching, reasoning, machine learning,and language processing.

Expected StudentBackground (Preconditions)

Students areexpectedtohave a sound understanding ofartificialintelligence techniques and the fundamentals ofcomputing before commencing this course. These include planning, knowledge representation, advancedsearchtechniques, and heuristicapproaches to problem solving.

Topics Outline:

S No	Topics	Hrs
1	Logic and ArtificialIntelligence	7
2	Automated planning and scheduling	6
3	Optimization Techniques in Artificial Intelligence	10
4	Uncertain Knowledge and Reasoning	11
5	Expert Systems andArtificial Intelligence	8
6	SwarmIntelligence andNaturallevel processing	6
		48

References

1. Z. Michalewicz and D.B. Fogel, *How to SolveIt:ModernHeuristics* ,Springer-Verlag,

2000.
2. E. Aartsand J.K. Lenstra, *Local Search in Combinatorial Optimization* ,Priceton University Press, 2003.
3. D. Corne, M. Dorigo,F. Glover, *New Ideas inOptimisation* , McGraw-Hill, 1999.
4. J.J. Schneider and S.Kirpatric, *Stochastic Optimization*, Springer-Verlag, 2006.

Evaluation Scheme:

S No	Examination	Marks
1	T-1	15
2	T-2	25
3	T-3	35
4	*Internal Marks	25

CRYPTOGRAPHY AND INFORMATION SECURITY

COURSE CODE: XXX
COURSE CREDITS: 3
CORE/ELECTIVE: ELECTIVE
L-T-P: 3-0-0

Pre-requisite Course: Computer Networks, Discrete Mathematics

Description & Rationale:

In this module, students will be provided with the contemporary knowledge of Cryptography techniques along with the security of information systems. It focuses on introducing the concepts, principles, techniques and methodologies required to design and assess the security of information exchange over complex networks, information systems and applications.

Objectives:

- To understand how cryptography can be used as an effective tool in providing assurance concerning privacy and integrity of information.
- To recognize the concept of encryption/decryption.
- To describe the different types of ciphers along with the identification of the characteristics of a good cipher.
- To provide skills to design security protocols for solving security problems.
- To develop skills necessary to help organizations in designing, testing and implementing well-planned information security measures for for information systems.

Course Outcomes:

S No	Course outcomes (Cryptography and Information System Security)	Level of Attainment
CO-1	To understand a variety of generic security threats and vulnerabilities, and identify &analyze particular security problems for a given application.	Familiarity
CO-2	To gain knowledge on the notions of various types cryptography techniques.	Familiarity
CO-3	To understand and analyze the various cryptography techniques, their principles and applications.	Familiarity and Assessment
CO-4	To identify and analyze the applications of security techniques and technologies in solving real life security problems.	Usage
CO-5	To understand, analyze and evaluate the security of information systems.	Familiarity, Usage and Assessment
CO-6	To analyze and interpret the mechanisms to provide security for communicating information.	Assessment

Course Contents / Lecture Plan:

S No	Topics	Hrs
1	**Introduction:** Security Attacks: Motives, vulnerabilities, Defense strategies and techniques, Various Attacks- DoS, DDoS, Session Hijacking and Spoofing, Phishing, Buffer Overflow, Format String Attacks, SQL Injection, Malicious Software, Prevention and Detection, Data Protection, Response, Recovery and Forensics.	4
2	**Basics of Cryptography:** Symmetric Cipher Model, Substitution Techniques, Transportation Techniques, Other Cipher Properties- Confusion, Diffusion, Block andStream Ciphers.	4
3	**Secret Key Cryptography:** Data Encryption Standard (DES), Strength of DES, Block Cipher, Design Principles and Modes of Operations, Triple DES.	6
4	**Public Key Cryptography:** Principles of Public Key Cryptosystems, RSA Algorithm, Diffie-Hellman Key Exchange algorithm	5
5	**Cryptographic Hash Functions:** Applications of Cryptographic Hash Functions, Secure Hash Algorithm, Message Authentication Codes – Message Authentication Requirements and Functions, HMAC, Digital signatures, Digital Signature Schemes, Authentication Protocols, Digital Signature Standards. Authentication Applications-Kerberos, Key Management and Distribution, X.509 Directory Authentication service, Public Key Infrastructure.	7
6	**Electronic Mail Security**-Pretty Good Privacy, S/MIME**, Operating System Protection**-Memory and Address protection, File Protection Mechanism, User Authentication. **Database Security-**Security Requirement, Reliability and Integrity, Sensitive data, Multilevel Databases.	6
7	**IP Security:** Overview, Architecture, Authentication Header, Encapsulating SecurityPayload, Combining security Associations, Internet Key Exchange, WebSecurity: Web Security Considerations, Secure Sockets Layer andTransport Layer Security, Electronic Payment.	5
8	**Intrusion Detection Systems and Firewalls** Intruders, Intrusion Detection, Password Management, Firewalls-Need, Characteristics, Types of Firewalls, Placement of Firewalls, FirewallConfiguration, Trusted systems.	5
	Total	**42**

Tools and Technologies: None

Evaluation Scheme:

S No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Tutorials / Assignments, Quizzes, Attendance	25	Entire Semester	Assignment (5) - 9 Quizzes (5) - 12 Attendance - 4

Text Book(s):

T1: 'Cryptography and Network Security- Principles and Practices' by William Stallings, 8th Edition, Prentice Hall Publication
T2: 'Network security and Cryptography' by Bernard Menezes, Ist Edition, Cengage Learning Publication
T3: 'Computer Security- Principles and Practice' by William Stallings, Ist Edition, Pearson Education

Reference Book(s):

R1: 'Network Security Essentials' by William Stallings, 4th Edition, Pearson Publication
R2: 'Applied Cryptography' by Bruce Schneier, Edition 2001, Wiley & Sons Inc
R3: 'Cryptography and Network', 2nd edition, by Behrouz A Fourouzan, Debdeep Mukhopadhyay, TMH.

Web Resources:
https://onlinecourses.nptel.ac.in/noc18_cs07/preview
https://ieeexplore.ieee.org/xpl/RecentIssue.jsp?punumber=8013
https://link.springer.com/journal/145

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

S No	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Weightage
CO-1	H	M	M	H	M	H	H	H	L	H	M	M	81%
CO-2	H	H	H	M	L	H	H	H	M	H	M	M	83%
CO-3	H	H	H	L	M	H	M	H	M	H	M	H	83%
CO-4	H	H	H	M	M	M	H	M	M	M	H	H	83%
CO-5	H	H	H	M	M	M	M	M	L	M	M	H	75%
CO-6	H	H	H	H	M	H	H	M	M	H	H	M	89%
	100%	96%	96%	78%	63%	89%	93%	85%	59%	81%	85%	85%	

Data Warehousing and Data Mining

COURSE CODE: XXX
COURSE CREDITS: 03
CORE/ELECTIVE: ELECTIVE
L-T-P: 3-0-0

Pre-requisites: Data Structures, Compilers, Operating Systems, Computer Networks, Machine Learning and Genetic Algorithms.

Course Objective:

1. To describe the concept of Data warehouse & its attributes
2. To study different data warehouse models, architectures and implementation
3. To understand the basic concept of data mining and its functionality
4. To understand the concept of classification techniques and its implementation
5. To understand the concept of association rules, different techniques and implementation details 6. To understand the concept of cluster analysis, anomaly detection and its usage and implementation details

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	To describe the concept of Data Warehouse & its attributes	Assessment
CO-2	To study different data warehouse models, architectures and implementation	Assessment
CO-3	To understand the basic concept of data mining and its functionality	Assessment
CO-4	To understand the concept of classification techniques and its implementation	Assessment
CO-5	To understand the concept of association rules, different techniques and implementation details	Assessment
CO-6	To understand the concept of cluster analysis, anomaly detection and its usage and implementation details	Usage

Course Contents:

Unit	Contents	Lectures required
1	Introduction: Concepts of Data Warehouse and Data Mining including its functionalities, stages of Knowledge discovery in database(KDD) , Setting up a KDD environment, Issues in Data Warehouse and Data Mining, Application of Data Warehouse and Data Mining	**5**
2	Architecture: DBMS vs. Data Warehouse, Data marts, Metadata, Multidimensional data model, Data Cubes, Schemas for Multidimensional Database: Stars, Snowflakes and Fact Constellations, Data Warehouse Architecture, Distributed and Virtual Data Warehouse, Data Warehouse Manager, OLTP, OLAP, MOLAP, HOLAP, types of	**8**

	OLAP, servers	
3	Introduction: Data Mining, Motivation, Challenges, Origins of Data Mining, Data Mining Tasks, Data: Types of Data, Data Quality, Data Pre-processing, Measures of Similarity and Dissimilarity, Exploring Data: Iris Data Set, Summary Statistics, Visualization, OLAP and Multi dimensional Data Analysis	**5**
4	Classification: Basic Concepts and Preliminaries, Approach to Solving a Classification Problem, Decision Tree Induction, Model Over fitting, Evaluating Performance of Classifier Alternative Techniques: Rule-Based Classifier, NearestNeighbour Classifiers, Artificial Neural Network (ANN), Support Vector Machine (SVM), Ensemble Methods, Class Imbalance Problem, Multiclass Problem	**8**
5	Association Analysis: Basic Concepts and Problem Definition, Frequent Itemset Generation, Rule Generation, Representation of Frequent Itemsets, FP-Growth Algorithm, Evaluation of Association Patterns, Handling Categorical Attributes , Handling Continuous Attributes, Handling a Concept Hierarchy, Sequential Patterns, Subgraph Patterns	**8**
6	Cluster Analysis: Basic Concepts, Characteristics of Data, Clusters, Partitional Clustering, Agglomerative Hierarchical Clustering, Prototype-Based Clustering, Density-Based Clustering, Graph-Based Clustering, Cluster Evaluation Anomaly Detection: Preliminaries, Statistical Approaches, Proximity-Based Outlier Detection, Density-Based Outlier Detection, Clustering-Based Techniques	**8**
	Total lectures	**42**

Evaluation Scheme:

S No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Tutorials / Assignments, Quizzes, Attendance	25	Entire Semester	Assignment (5) - 9 Quizzes (5) - 12 Attendance - 4

Suggested Text Book(s):

1. Data Mining Concepts and Techniques J. Han and M. Kamber Morgan Kaufmann, 2006, ISBN 1-55860- 901-6

2. Introduction to Data Mining Pang-Ning Tan, Michael Steinbach, Vipin Kumar, Pearson Education (Addison Wesley), 0-321-32136-7

Suggested Reference Book(s):

1. Mining Massive data sets Anand Rajaram, Jure Leskovec and Jeff Ullman Cambridge University Press
2. https://onlinecourses.nptel.ac.in/noc18_cs14/preview
3. https://www.coursera.org/specializations/data-mining.
4. https://www.futurelearn.com/courses/data-mining-with-weka

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Weightage
CO-1	3	2	1	2	2	2	2	2	2	1	1	2	1.8
CO-2	3	3	3	3	3	3	2	3	3	1	1	3	2.6
CO-3	3	3	3	3	2	2	1	2	3	2	3	3	2.5
CO-4	3	1	2	1	2	1	1	2	1	2	2	2	1.7
CO-5	3	3	3	3	2	3	1	2	3	2	3	3	2.6
CO-6	3	2	1	2	2	1	2	2	2	1	1	2	1.8
Weightage	3	2.3	2.2	2.3	2.2	2	1.5	2.3	2.2	1.5	1.8	2.5	

Data Visualization

COURSE CODE: XXX
COURSE CREDITS: 03
CORE/ELECTIVE: ELECTIVE
L-T-P: 3-0-0

Pre-requisite: Basic knowledge of high school mathematics and reasonable programming experience

Course Objectives:

- Asking the correct questions and analyzing the raw data.
- Modeling the data using various complex and efficient algorithms.
- Visualizing the data to get a better perspective.
- Understanding the data to make better decisions and finding the final result.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	Understanding the basics of data science	Familiarity
CO-2	Using versatile and flexible languages (Python and R programming) for supporting data science	Usage
CO-3	Using data processing for collecting and manipulating the data into usable and desired form	Usage
CO-4	Using data visualization to easily access the huge amount of data in visuals	Usage
CO-5	Using statistics to collect and analyze the numerical data in a large amount and finding meaningful insights from i	Usage
CO-6	Understanding linear algebra to represent, model, synthesize, and summarize the complex data	Usage

Course Contents:

Unit	Contents	Lectures required
1	Data Science an Introduction: Computer Science, Data Science, and Real Science, What is Data Science? Need for Data Science, Data Science Components, Tools for Data Science, Data Science Lifecycle, Applications of Data Science	**6**
2	Python and R Programming for Data Science for Data Science: Introduction to Python Programming (Python Basics, Python Data Structures, Python Programming Fundamentals, Working	**6**

	with Data in Python, Working with NumPy, Pandas, SciPy, and Matplotlib). Introduction to R Programming (R basics, Data structures in R, R Programming fundamentals, Working with Data in R, Stings and Dates in R,)	
3	Data Processing: Data Operations, Data cleansing, Processing CSV Data, Processing JSON Data, Processing XLS Data, Relational databases, NoSQL Databases, Date and Time, Data Wrangling, Data Aggregation, Reading HTML Pages, Processing Unstructured Data, Word tokenization, Stemming and Lemmatization	**8**
4	Statistical Data Analysis: Measuring Central Tendency, Measuring Variance, Normal Distribution, Binomial Distribution, Poisson Distribution, Bernoulli Distribution, P-Value, Correlation, Chi-square Test, Linear Regression	**8**
5	Linear Algebra: Visualizing Matrix Operations (Matrix Addition, Matrix Multiplication, Applications of Matrix Multiplication, Identity Matrices and Inversion, Matrix Inversion and Linear Systems, Matrix Rank) Factoring Matrices (Why Factor Feature Matrices, LU Decomposition and Determinants), Eigen values and Eigenvectors (Properties of Eigen values, Computing Eigen values), Eigen value Decomposition (Singular Value Decomposition, Principal Components Analysis)	**8**
6	Data Visualization: Chart Properties, Chart Styling, Box Plots, Heat Maps, Scatter Plots, Bubble Charts, 3D Charts, Time Series, Geographical Data, Graph Data	**6**
	Total lectures	**42**

Evaluation Scheme:

S No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Tutorials / Assignments, Quizzes, Attendance	25	Entire Semester	Assignment (5) - 9 Quizzes (5) - 12 Attendance - 4

Suggested Text Book(s):

- Data Science from Scratch by Joel Grus
- Data Science for Dummies by Lillian Pierson and Jake Porway
- An Introduction to Statistical Learning by Gareth James , Daniela Witten , et al.

Reference Book(s):

- An Introduction to Probability and Statistics by V.K. Rohatgi & A.K. Md. E. Saleh, Wiley, (2008), 3rd ed.
- Introduction to Probability Theory and Statistical Inference by H.J. Larson, John Wiley & Sons, (2005) 3rd ed.

Other useful resource(s):

- https://nptel.ac.in/courses/110/106/110106064/
- https://onlinecourses.nptel.ac.in/noc18_cs28/preview

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Weightage
CO-1	2	2	2	3	2	1	1	1	3	2	2	1	1.8
CO-2	3	3	3	3	3	1	1	2	2	2	1	1	2.1
CO-3	2	2	2	2	1	1	2	2	2	2	1	2	1.8
CO-4	3	3	3	3	2	1	1	3	2	3	3	2	2.4
CO-5	3	2	3	3	1	1	2	1	1	3	2	1	1.9
CO-6	2	2	1	2	2	2	3	2	1	2	3	1	1.9
Weightage	2.5	2.3	2.3	2.7	1.8	1.2	1.7	1.8	1.8	2.3	2	1.3	

Data Storage Technologies

COURSE CODE: XXX
COURSE CREDITS: 03
CORE/ELECTIVE: ELECTIVE
L-T-P: 3-0-0

The course focuses on designing, implementing, and administering storage for today's evolving organizations, getting under the hood of the technologies that enable performance, resiliency, availability, recoverability, and simplicity.

Course Outcomes:

S No	Course outcomes	Level of Attainment
CO-1	Students will learn about the Storage Media and Technologies	Familiarity
CO-2	To introduce students to the Memory Hierarchy and design the Hardware and Software for access	Assessment
CO-3	To study the Large Storages and Scalability issues	Assessment
CO-4	To analysis and discuss the Storage Partitioning, Storage System Design, Legacy Systems	Usage
CO-5	Students will analysis the Performance, Reliability, and Security issues	Usage
CO-6	Design and develop the model for any real world application using Data Storage Technologies	Usage

Course Contents / Lecture Plan:

S No	Topics	Hrs
1	Storage Media and Technologies: Magnetic, Optical and Semiconductor Media, Techniques for read/write Operations, Issues and Limitations	8
2	Usage and access Positioning in the Memory Hierarchy, Hardware and Software Design for Access, Performance issues	8
3	Large storages Hard Disks, Networked Attached Storage, Scalability issues	8
4	Storage architecture Storage Partitioning, Storage System Design, Caching, Legacy Systems	8
5	Storage area networks Hardware and Software Components, Storage Clusters/Grids. Storage QoS– Performance, Reliability, and Security issues	10
	Total	42

Evaluation Scheme:

S No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered uptoT-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Tutorials / Assignments, Quizzes, Attendance	25	Entire Semester	Assignment (2) -10 Quizzes (2) - 10 Attendance -5

TEXT BOOKS

The Complete Guide to Data Storage Technologies for Network-centric ComputingPaperback– Import, Mar 1998 by Computer Technology Research Corporation

REFERENCE BOOKS

Data Storage Networking: Real World Skills for the CompTIA Storage by Nigel Poulton,2014

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

S No	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Total
CO-1	2	2	2	3	2	1	1	1	3	2	2	1	1.8
CO-2	3	3	3	3	3	1	1	2	2	2	1	1	2.1
CO-3	2	2	2	2	1	1	2	2	2	2	1	2	1.8
CO-4	3	3	3	3	2	1	1	3	2	3	3	2	2.4
CO-5	3	2	3	3	1	1	2	1	1	3	2	1	1.9
CO-6	2	2	1	2	2	2	3	2	1	2	3	1	1.9
Average Score	2.5	2.3	2.3	2.7	1.8	1.2	1.7	1.8	1.8	2.3	2	1.3	2.0

Introduction to Statistical Learning

COURSE CODE: XXX
COURSE CREDITS: 3
CORE/ELECTIVE: OPEN ELECTIVE
L-T-P: 2-0-1
Pre-requisite: Basics of programming and mathematics.
Course Objectives:

- To understand the fundamentals of statistical learning and, analyzing regression and classification.
- To understand and analyze pre-processing data and model selection.
- To understand and analyze non-linear and tree based regression.
- To understand and analyze Support Vector Classifier and Machines, and unsupervised learning.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Understanding statistical learning and, analyzing regression and classification.	Familiarity and usage
CO-2	Analyzing resampling, model selection and regularization.	Usage
CO-3	Analyzing non-linear and tree based regression.	Usage
CO-4	Analyzing Support Vector Machines and unsupervised learning	Usage

Course Contents:

Unit	Contents	Lectures required
1	**Introduction to statistical learning:** Prediction accuracy, Model interpretability, Supervised and Unsupervised learning, Assessing model accuracy	**3**
2	**Regression and Classification:** Regression- Linear, MultiLinear and kNN, Classification-Logistic regression, Linear and quadratic discriminant analysis, and kNN	**6**
3	**Resampling, Model Selection and Regularization:** Cross-validation, the bootstrap, Subset selection, Shrinkage methods, Dimension reduction methods, considerations in high dimension	**7**
4	**Non-linear Regression:** Polynomial regression, Step functions, Regression splines, Smoothing splines, Local regression, Generalized additive methods, **Tree Based Regression:** the basics of decision trees, Bagging, Random forest and Boosting,	**7**
5	**Support Vector Machines:** Maximal margin classifier, Support Vector Classifier and Support Vector Machines, **Unsupervised Learning:** The challenges, Principal Component Analysis, Clustering methods	**6**
	Total lectures	**42**

Suggested Text Book(s):

- Gareth, James, Witten Daniela, Hastie Trevor, and Tibshirani Robert. *An introduction to statistical learning: with applications in R*. Spinger, 2013.

Suggested Reference Book(s):

5. Friedman, Jerome, Trevor Hastie, and Robert Tibshirani. *The elements of statistical learning*. Vol. 1, no. 10. New York: Springer series in statistics, 2001.
6. Kulkarni, Sanjeev, and Gilbert Harman. *An elementary introduction to statistical learning theory*. Vol. 853. John Wiley & Sons, 2011.
7. MELLO, RODRIGO F., and Moacir Antonelli Ponti. *Machine Learning: A Practical Approach on the Statistical Learning Theory*. Springer, 2018.

EvaluationScheme:

S No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes(2) -10 Attendance – 3 Participation in class-2

Course Outcomes (COs) contribution to the Programmed Outcomes (POs)

Course Outcomes	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	3	3	3	3	1	1	2	1	3	2	**2.33**
CO-2	3	3	3	3	3	3	2	1	2	1	3	2	**2.42**
CO-3	3	3	3	3	3	3	2	1	2	1	3	2	**1.42**
CO-4	3	3	3	3	3	3	1	1	2	1	3	2	**2.33**
Average	**3**	**3**	**3**	**3**	**3**	**3**	**1.5**	**1**	**3**	**1**	**3**	**3**	

Knowledge-Based AI: Cognitive Systems

COURSE CODE: XXX
COURSE CREDITS: 3
CORE/ELECTIVE: ELECTIVE
L-T-P: 3-0-0

Pre-requisite: Discrete Mathematics, Programming Languages

Course Objectives:

The course aims to familiarize the students with the basic concepts as well as with the state-of-the-art research literature in knowledge-based artificial intelligence. After successful completion of this course, students will be able to:

1. Understand concepts, methods, and prominent issues in knowledge-based artificial intelligence
2. Learn specific skills and abilities needed to apply those concepts to the design of knowledge-based AI agents
3. Understand the relationship between knowledge-based artificial intelligence and the study of human cognition.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	Understanding the basic concepts of knowledge-based AI & Cognitive Systems	Familiarity
CO-2	Understanding various fundamental concepts & techniques related to AI as well as cognitive systems.	Familiarity
CO-3	Learning & implementing various reasoning methods such as common sense reasoning, analogical reasoning, etc	Usage
CO-4	Designing & creating as well as metacognition knowledge	Assessment

Course Contents:

Unit	Contents	Lectures Required
1	**Introduction:** Introduction to KBAI & Cognitive Systems, Where Knowledge-Based AI fits into AI as a whole - Cognitive systems: what are they? - AI and cognition: how are they connected?	**5**
2	**Fundamentals:** Semantic Networks - Generate & Test - Means-Ends Analysis - Problem Reduction - Production	**5**

	Systems	
3	**Common Sense Reasoning**: Frames - Understanding - Common Sense Reasoning - Scripts	**4**
4	**Planning & Learning:** Logic, Planning, Learning by Recording Cases - Incremental Concept Learning - Classification - Version Spaces & Discrimination Trees	**6**
5	**Analogical Reasoning:** Case-Based Reasoning - Explanation-Based Learning - Analogical Reasoning	**5**
6	**Visuospatial Reasoning:** Constraint Propagation - Visuospatial Reasoning	**5**
7	**Design & Creativity:** Configuration - Diagnosis - Design - Creativity	**6**
8	**Metacognition:** Learning by Correcting Mistakes - Meta-Reasoning - AI Ethics	**6**
	Total Lecture Hours	**42**

Suggested Text Book(s):

- Russell, Stuart, and Peter Norvig. "Artificial intelligence: a modern approach." (2002).
- Vernon, David. Artificial cognitive systems: A primer. MIT Press, 2014.

Suggested Reference Book(s):

- Rothman, Denis. *Artificial Intelligence by Example: Develop machine intelligence from scratch using real artificial intelligence use cases*. Packt Publishing Ltd, 2018.

Other useful resources (s):

Link to NPTEL course contents:

- https://nptel.ac.in/courses/106/105/106105077/

Link to topics related tocourse:

- https://www.youtube.com/watch?v=0Alhb1HDsNw
- https://www.youtube.com/watch?v=JMUxmLyrhSk
- https://www.udacity.com/course/knowledge-based-ai-cognitive-systems--ud409

EvaluationScheme:

S No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered up to T-1
2	T-2	25	1.5 Hours	Syllabus covered up to T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes(2) -10 Attendance – 3 Participation in class-2

Course Outcomes (COs) contribution to the Program Outcomes (POs)

Course outcomes (Knowledge-Based AI: Cognitive Systems)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	1.8
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	2
CO-3	2	2	3	3	3	1	1	1	2	2	1	2	1.9
CO-4	2	3	3	3	2	1	1	1	2	3	1	2	2
Average	2	2.5	2.8	2.8	2.5	1	1	1	2	2.3	1.3	2	1.9

Medical Image Analysis

COURSE CODE: XXX
COURSE CREDITS: 03
CORE/ELECTIVE: ELECTIVE
L-T-P: 3-0-0

This course focuses on classical and machine learning based techniques for medical image analysis.

Course Outcomes:

S No	Course outcomes (Medical Image Analysis)	Level of Attainment
CO-1	To introduce students to the outline the Medical Image Analysis.	Familiarity
CO-2	To interpret and analyse the images in a quantitative way.	Assessment
CO-3	To apply the machine Learning and Deep Learning Approaches for medical image analysis,	Assessment
CO-4	To apply the learned techniques for novel disease diagnosis and prognosis.	Usage

Course Contents / Lecture Plan:

S No	Topics	Hrs.
1	Introduction to image processing and medical imaging modalities, denoising and enhancement	5
2	Tissue and Cell Segmentation: clustering, active contours and level sets based approaches	5
3	Medical Image alignment: rigid and deformable registration	5
4	Fundus Image analysis, Retinal Vessel Segmentation	5
5	MRI image analysis and segmentation, 3D brain reconstruction from and MRI slices and analysis	5
6	Microscopic image analysis and interpretation	5
7	X-Ray and CT image segmentation, diagnosis and prognosis of various diseases	6
8	Correlation between different medical imaging modalities and conversions, augmenting clinical measurements with medical imaging modalities for diseases diagnosis and prognosis	6
	Total	42

Evaluation Scheme:

S No	Exam	Marks	Duration	Coverage/Scope of Examination
1	T-1	15	1 Hr.	Syllabus covered upto Mid Semester
2	T-2	25	1.5 Hrs	Full Syllabus
2	T-3	35	2 Hrs	Full Syllabus
3	Regularity, Assignment and Quiz	25	Entire Semester	Regularity-4, Assignments- 9, Quiz – 12

Text Books

1. Prince, J. L., & Links, J. M. (2006). Medical imaging signals and systems. Upper Saddle River, NJ: Pearson Prentice Hall.
2. Suetens, P. (2017). Fundamentals of medical imaging. Cambridge university press.

Self-Learning Material:

Medical Image Processing by Prof. Jeff Orchard at University of Waterloo: https://cs.uwaterloo.ca/~jorchard/cs473/CS473/Welcome.htm

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

S No	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Total
CO-1	3	1	1	1	2	2	1	2	2	1	2	3	**1.8**
CO-2	3	2	1	2	2	2	1	2	2	1	3	2	**1.9**
CO-3	2	2	3	2	2	1	3	2	1	1	1	1	**1.8**
CO-4	2	2	3	2	2	1	3	2	1	1	1	1	**1.8**
Average Score	**2.5**	**1.8**	**2**	**1.8**	**2**	**1.5**	**2**	**2**	**1.5**	**1**	**1.8**	**1.8**	**1.8**

Natural Language Processing

COURSE CODE: 14M1WCI333
COURSE CREDITS: 03
CORE/ELECTIVE: ELECTIVE
L-T-P: 3-0-0

Pre-requisite:
Knowledge of CS's Core and System Courses on Programming, Data Structure, Algorithms, Artificial Intelligence.

Course Objectives (Post-conditions)

Knowledge objectives:
On completion of the course, you are expected to develop
a) Ability to analyze natural language phenomenon and create models mimicking human behavior.
b) Ability to design and build NLP application systems in real life based on societal needs.
c) Ability to evaluate NLP software systems.
d) Ability to develop software systems that learn from real life data
e) Ability to re-engineer components of a NLP software in a multi-lingual environment and evolving language scenario.
f) Ability to translate a specification into a design, and then realize that design practically, using an appropriate processing tools and methods.

Topics Outline:

S No	Topic	Hrs
1	Introduction, NLP applications, Ambiguities, Role of syntax, semantics, context, world-knowledge & pragmatics, Rule-based approach, vs. Statistical approach to analysis	3
2	Fundamental aspects of English grammar; Contrastive examples from Hindi, Linguistic resources, Morphological Analysis and synthesis,	4
3	Syntactic Analysis, TN, RTN, ATN, CFG, Probabilistic CFG,	7
4	Collocations, Multi-word expressions, Named entities,	4
5	Language modeling, Markov models, Hidden Markov Models, Parts of speech tagging,	8
6	Word Sense Disambiguation, Pronoun reference disambiguation,	5
7	Text similarity, Text categorization, Text Summarization,	3
8	Sentiment Analysis,	2
9	Information Retrieval, Question Answering,	3
10	Natural Language Generation, Machine Translation.	3
	Total	**42**

Evaluation Scheme:

S No	Exam	Marks	Duration	Coverage/Scope of Examination
1	T-1	15	1 Hr.	Syllabus covered upto Mid Semester
2	T-2	25	1.5 Hrs	Full Syllabus
2	T-3	35	2 Hrs	Full Syllabus
3	Regularity, Assignment and Quiz	25	Entire Semester	Regularity-4, Assignments- 9, Quiz – 12

References

1. Daniel Jurafsky& James H.Martin, " Speech and Language Processing", Pearson Education (Singapore) Pte. Ltd., 2002.
2. James Allen, "Natural Language Understanding", Pearson Education, 2003
3. C.D. Manning and H. Schutze, "Foundations of Statistical Natural Language Processing", MIT Press, 1999.
4. Daniel M. Bikel and ImedZitouni (ed.), "Multilingual Natural Language Processing Applications: From Theory to Practice", Pearson Education, 2013

Reinforcement Learning

COURSE CODE: XXX
COURSE CREDITS: 3
CORE/ELECTIVE: ELECTIVE
L-T-P: 3-0-0
Pre-requisite: Probability & Statistics, Machine Learning

Course Objectives:
The course aims to familiarize the students with the basic concepts as well as with the state-of-the-art research literature in deep reinforcement learning. After successful completion of this course, students will be able to:

1. Structure of a reinforcement learning problem
2. Understand and apply basic RL algorithms for simple sequential decision-making problems in uncertain conditions.
3. Evaluate the performance of the solution
4. Interpret state-of-the-art RL research and communicate their results.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	Understanding the basic concepts of Reinforcement Learning	Familiarity
CO-2	Understanding Probability Primer Techniques in detail.	Familiarity
CO-3	Learning & implementing various methods & techniques such as TD methods, Monte Carlo, Markov Decision Process, etc.	Usage
CO-4	Learning & understanding policy gradients along with its advantages and disadvantages.	Assessment

Course Contents:

Unit	Contents	Lectures Required
1	**Introduction:** Origin and history of Reinforcement Learning research. Its connections with other related fields and with different branches of machine learning.	**2**
2	**Probability Primer:** Axioms of probability, concepts of random variables, PMF, PDFs, CDFs, Expectation. Concepts of joint and multiple random variables, joint, conditional and marginal distributions. Correlation and independence.	**4**
3	**Markov Decision Process:** Introduction to RL terminology, Markov property, Markov chains, Markov reward process (MRP). Introduction to and proof of Bellman equations for MRPs along with proof of existence of solution to Bellman equations in MRP. Introduction to Markov decision process	**6**

	(MDP), state and action value functions, Bellman expectation equations, optimality of value functions and policies, Bellman optimality equations.	
4	**Prediction & Control by Dynamic Programming:** Overview of dynamic programming for MDP, definition and formulation of planning in MDPs, principle of optimality, iterative policy evaluation, policy iteration, value iteration, Banach fixed point theorem, proof of contraction mapping property of Bellman expectation and optimality operators, proof of convergence of policy evaluation and value iteration algorithms, DP extensions.	**6**
5	**Monte Carlo methods for Model Free Prediction &Control :**Overview of Monte Carlo methods for model free RL, First visit and every visit Monte Carlo, Monte Carlo control, On policy and off policy learning, Importance sampling.	**6**
6	**TD Methods:** Incremental Monte Carlo Methods for Model Free Prediction, Overview TD(0), TD(1) and TD(λ), k-step estimators, unified view of DP, MC and TD evaluation methods, TD Control methods - SARSA, Q-Learning and their variants.	**6**
7	**Function Approximation Methods:** Getting started with the function approximation methods, Revisiting risk minimization, gradient descent from Machine Learning, Gradient MC and Semi-gradient TD(0) algorithms, Eligibility trace for function approximation, After states, Control with function approximation, Least squares, Experience replay in deep Q-Networks.	**6**
8	**Policy Gradients:** Getting started with policy gradient methods, Log-derivative trick, Naive REINFORCE algorithm, bias and variance in Reinforcement Learning, Reducing variance in policy gradient estimates, baselines, advantage function, actor-critic methods.	**6**
	Total Lecture Hours	**42**

Suggested Text Book(s):

- Sutton, Richard S., and Andrew G. Barto. "Reinforcement learning: An introduction." (2011).
- Leon-Garcia, Alberto. "Probability, statistics, and random processes for electrical engineering." (2017).

Suggested Reference Book(s):

- Murphy, Kevin P. *Machine learning: a probabilistic perspective*. MIT press, 2012.

Other useful resources (s):

1. Link to NPTEL course contents:
   - https://nptel.ac.in/courses/106/106/106106143/
2. Link to topics related tocourse:
   - https://www.youtube.com/watch?v=JgvyzIkgxF0
   - https://www.youtube.com/watch?v=LzaWrmKL1Z4

EvaluationScheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered up to T-1
2	T-2	25	1.5 Hours	Syllabus covered up to T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes(2) -10 Attendance – 3 Participation in class-2

Course Outcomes (COs) contribution to the Program Outcomes (POs)

Course outcomes (Reinforcement Learning)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	2	2	2	2	1	2	1.8
CO-2	2	3	3	3	3	1	3	2	2	2	1	2	2.3
CO-3	2	3	3	3	3	2	3	2	2	2	1	2	2.3
CO-4	2	3	3	3	2	1	2	3	2	3	2	2	2.3
Average	2	2.8	2.8	2.8	2.5	1.3	2.5	2.3	2	2.3	1.3	2	2.2

Social and Information Network Analysis

COURSE CODE: XXX
COURSE CREDIT: 2
CORE/ELECTIVE: ELECTIVE
L-T-P: 2-0-0
Pre-requisites: Graph Theory, Probability

Course Objectives:

1. To analyze the large networks on models and algorithms that abstracts their basic properties.
2. To explore how to practically analyze large-scale network data and how to reason it through models for network structure and evolution
3. To do the friend prediction in online social networks
4. To identify the functional modules in biological networks and disease outbreak detection.

Course outcomes:

S No	Course Outcomes	Level of Attainment
CO-1.	Understand what constitutes a social network	Familiarity
CO-2.	Represent networks in graph-theoretic language	Assessment
CO-3.	Design effective and reliable network research projects	Assessment
CO-4.	Configure network and attribute data for standard software packages	Assessment
CO-5.	Comprehend the reasons for using, and principles of, permutation tests	Assessment
CO-6.	Apply centrality measures appropriately	Assessment

Course Contents:

	Topics	Topics Outcomes	No of Lectures
1	Introduction	1.Understand what constitutes a social network 2. Identify and describe different levels of analysis 3. Formulate problems in terms of network variables	3
2	Mathematical Foundations	1. Represent networks in graph-theoretic language 2. Identify paths, walks, trails and components 3. Formulate networks in matrix terms 4. Compute and interpret multiplication of adjacency matrices	4
3	Research Design	1. Design effective and reliable network research projects 2. Identify sources and boundaries of network data 3. Understand and minimize the effects of data error	4
4	Data Collection	1. Identify sources of network data 2. Design effective network questionnaires 3. Mine archival and electronic sources for network data	3
5	Data	1. Configure network and attribute data for standard	4

	Management	software packages 2. Apply elementary transformations to matrix data 3. Extract and reconfigure network and attribute data	
6	Multivariate Techniques Used in Network Analysis	1. Represent one- and two-mode data in a two-dimensional map 2. Cluster data into groups using hierarchical clustering 3. Correctly interpret the information contained in the clusters and maps	4
7	Visualization	1. Visualize networks with or without node attributes in a meaningful way 2. Embed edge characteristics in network diagrams 3. Represent network change over time graphically	4
8	Testing Hypotheses	1. Comprehend the reasons for using, and principles of, permutation tests 2. Formulate testable hypotheses at the dyadic, monadic and whole-network level 3. Understand when SIENA and exponential random graph models may be appropriate	4
9	Characterizing Whole Networks	1. Calculate and interpret cohesion measures in a whole network 2. Undertake a triad census 3. Compute and evaluate measures of transitivity, reciprocity and clustering	4
10	Centrality	1. Apply centrality measures appropriately 2. Interpret the results of a centrality analysis on undirected, directed and valued data 3. Understand the limitations and constraints of the standard centrality measures	4
11	Subgroups	1. Understand the similarities and differences of the main approaches in detecting cohesive subgroups 2. Select appropriate methods given the size and nature of the network 3. Perform a cohesive subgroup analysis on a variety of types of network	4
			Total=42

Evaluation Scheme:

S No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 hour.	Syllabus covered upto Test-1
2	T-2	25	1.5 hours	Syllabus covered upto Test-2
3	T-3	35	2 hours	Syllabus covered upto Test-3

4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) -10 Attendance - 5

Suggested Text Book(s):

1. Analyzing Social Networks 1st Edition by Stephen P Borgatti, Martin G. Everett, Jeffrey C. Johnson, SAGE Publications Ltd; 1 edition

Suggested Reference Book(s):

2. Influence and Behavior Analysis in Social Networks and Social MediabyMehmet Kaya, Reda Alhajj, Lecture Notes in Social Networks, Springer International Publishing
3. Emerging Research Challenges and Opportunities in Computational Social Network Analysis and Mining by Nitin Agarwal, NimaDokoohaki, Serpil Tokdemir, Lecture Notes in Social Networks, Springer International Publishing

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10-	PO-11	PO-12	Average
CO-1	3	3	3	2	2	3	2	2	2	3	1	3	2.4
CO-2	3	3	3	2	3	2	3	2	2	3	1	3	2.5
CO-3	3	3	3	2	2	3	1	2	3	3	1	3	2.4
CO-4	3	3	3	2	3	3	2	2	3	3	1	3	2.6
CO-5	3	3	3	2	3	3	2	2	3	3	1	3	2.6
CO-6	3	3	3	2	3	3	2	2	1	3	1	3	2.4
Average	3	3	3	2	2.7	2.8	2	2	2.3	3	1	3	

ANNEXURE - 12

REVISED COURSE CONTENTS OF ETHICS, PLAGIARISM & IPR ISSUES

Course title: Ethics Plagiarism&IPR Issues

Course code : 17P1WGE102
Course Coordinator: Dr HemantSood
Credit:1

Objective:

To provide an insight to the PhD students on different aspects of protection of inventions and research developments, academic, research and publication ethics .

Course Assessment:

Test -1	15
Test -2	25
Test -3	35
Teacher Assessment (Based on Assignments, pptand quizzes etc .) Attendance	25
Total	100

Course Outcomes:

CO1. To enable students with basic concepts of philosophy of science,ethics andintellectual property rights for protecting innovations in different sciences

CO2. Able to learn the mechanisms of publications and IP protections and registrations under different classifications

CO3. Able to tackle problems in research misconduct and intervene ethics and inve ntiveness for the benefit generation and mass utilization

CO4. To enable them for developing the strategies for handling issues related to IP, Ethics andplagiarism

CO5. Able to learn effective research integrity and useful publication for generating future perspectives

CO6. Able to learn different modes of tackling plagiarism and developing academic integrity

Topics	**Lecture hrs.**
Introduction to philosophy and its nature with scopes in different branches	1
Different types of IPR(Patents, coyrights, Trademark, Tradesecret, ICL,GI,TK and PBR)	2
Rationale of different IPR ,their mechanism of protection and provisions in Law	1
Ethics used in science and research and tools to follow it with case studies	2

Scientific misconduct: Falsification, Fabrication and Plagiarism

Plagiarism and misuse of Privileged Information 3

Data analysis include Integrity of Data ,Use and Misuse of Data ,Ownership of and Access to Data and Storage and Retention of Data

Responsibilities to Funding Agencies 2

Responsibilities of a Research Investigator 1

Ethics : Moral philosophy and nature of moral judgement w. r. t.Special Obligations in Human Subject Research and Laboratory Animals or any other technology with safety concern 3

Authorship and Other Publication Issues includes violations 3

1. Criteria for Authorship
2. Order of Authors
3. Self-citations
4. Conflict of interst
5. Duplicate Publication
6. Accessibility of Publications
7. Predatory publishers and journals

Practice

1. Open access publications and initiatives
2. SHERPA/RoMEO online resourceto check publisher
3. Software tools by SPPU
4. Journal finder/journal suggestion tools viz JANE,Elsevier,Springer etc
5. Plagiarism software tools Turntin and other open resources
6. Databases :citation databases (SCI,Web of science ,Scopus etc.) and Indexing databases
7. Impact factors and Metrics: h-index g index, i 10 index etc.

Assignments:

Each student should submit assignment in the form of hard copy on case studies linked with research of their respective areas like civil engineering, ECE, computer, biotechnology etc

Books:

1. Ethics in Research by Ian Gregory
2. IPR- A primer by R. Anita Rao and BhanojiRao
3. Intellectual Property Rights & Copyright By Bouchoux

Machine Learning Engineering for Production (MLOps)

COURSE CODE: 21B1WC…

COURSE CREDITS: 3

CORE/ELECTIVE: Professional Elective

L-T-P: 3-0-0

Pre-requisite: None

Objectives:

1. Design an ML production system end-to-end.
2. Establish a model baseline, address concept drift, and prototype how to develop, deploy, and continuously improve a productionized ML application.
3. Build data pipelines by gathering, cleaning, and validating datasets. Establish data lifecycle by using data lineage and provenance metadata tools.
4. Apply best practices and progressive delivery techniques to maintain and monitor a continuously operating production system.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Design an ML production system end-to-end: project scoping, data needs, modeling strategies, and deployment requirements.	Familiarity
CO-2	Establish a model baseline, address concept drift, and prototype how to develop, deploy, and continuously improve a productionized ML application.	Assessment
CO-3	Build data pipelines by gathering, cleaning, and validating datasets. Establish data lifecycle by using data lineage and provenance metadata tools.	Assessment
CO-4	Apply best practices and progressive delivery techniques to maintain and monitor a continuously operating production system.	Assessment

Course Contents:

Unit	Contents	Lectures required
1	**Introduction to Machine Learning in Production:** Overview of the ML Lifecycle and Deployment, Selecting and Training a Model, Data Definition and Baseline.	8
2	**Machine Learning Data Lifecycle in Production:** Collecting, Labeling, and Validating data, Feature Engineering, Transformation, and Selection, Data Journey and Data Storage, Advanced Data Labeling Methods, Data Augmentation, and Preprocessing Different Data Types.	12
3	**Machine Learning Modeling Pipelines in Production:** Neural Architecture Search, Model Resource Management Techniques, High-Performance Modeling, Model Analysis, Interpretability.	12
4	**Deploying Machine Learning Models in Production:** Model Serving Introduction, Model Serving Patterns and Infrastructures, Model Management and Delivery, Model Monitoring and Logging.	10
Total lectures		42

Suggested Text Book(s):

1. Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, 2nd Edition, Aurélien Géron, Released September 2019, O'Reilly Media, Inc., ISBN: 9781492032649.
2. Building Machine Learning Powered Applications, Emmanuel Ameisen, Released January 2020, O'Reilly Media, Inc., ISBN: 9781492045113.
3. Introducing MLOps: How to Scale Machine Learning in the Enterprise, Mark Treveil, O'Reilly

Media, Inc.,9781492083290

Other useful resource(s):

1. https://www.coursera.org/specializations/machine-learning-engineering-for-production-mlops
2. https://github.com/amanchadha/coursera-machine-learning-engineering-for-prod-mlops-specialization
3. https://nptel.ac.in/courses/106/105/106105152/
4. https://www.deeplearning.ai/program/machine-learning-engineering-for-production-mlops/
5. https://ml-ops.org/content/references.html

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Case Studies - 15 Quizzes (2) - 5 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Machine Learning Engineering for Production (MLOps)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	
Average													

DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

PROFESSIONAL ELECTIVES FOR 5th / 6th Semester (2017-18)

Applied Artificial Intelligence

COURSE CODE: 18B1WEC533

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

1. Study of design of expert systems which exhibit intelligent behavior.
2. Study of design and development of products using Artificial Intelligence.
3. Participate in the design of systems that act intelligently and learn from experience.
4. To study State of the Art algorithms with engineering applications.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Basic methods and algorithms from area of artificial intelligence	Familiarity
CO-2	Identify problems where artificial intelligence techniques are applicable.	Assessment
CO-3	Analysis of problem solving, knowledge and reasoning	Assessment
CO-4	Study of application domains.	Usage

Course Contents:

Unit	Contents	Lectures required
1	Introduction to Artificial Intelligence (AI): Overview of AI, Philosophy of AI, AI Foundation and History, Applications of AI in modern world.	8
2	Intelligent Agents: Agents and Environments, The structure of Agents, Agent Programs, Simple reflex Agents, Model based reflex Agents, Goal based Agents, Utility based Agents, Learning Agents.	8

3	Problem Solving, Knowledge and Reasoning: Problem solving Agents, Formulating Problems, Searching for Solutions, Uninformed Search Strategies, Knowledge based agents, Knowledge Representation, Uncertain Knowledge and Reasoning	7
4	Machine Learning: Machine learning concepts, K-nearest neighbours and training-testing Logistic regression, Decision trees, Neural networks, Clustering, Association rules	7
5	Reinforcement Learning: Learning from Observations, Knowledge in Learning, Statistical Learning, Reinforcement Learning, Perceptional Analysis, Communication as Action	6
6	Applications of AI Techniques: Semantic Interpretation, Probabilistic Language Processing, Robotic Hardware and Software Architectures, Probabilistic Inference, Planning and Search, Localization, Tracking and Control.	6
Total lectures		42

Suggested Text Book(s):

1. Stuart J. Russel and Peter Norvig: Artificial Intelligence: A Modern Approach, 3rd Ed., Pearson Education Limited, 2014.
2. E. Rich and K. Knight: Artificial Intelligence and Applications, 3rd Ed., Tata McGraw Hill, 2012.

Suggested Reference Book(s):

1. P. Kulkarni and P. Joshi: Artificial Intelligence, 2nd Ed., PHI Learning Private Limited, 2015.
2. P. H. Winston: Artificial Intelligence and Applications, 3rd Ed., PHI Learning Private Limited, 2017.

Other useful resource(s):

Link to topics related to course:

1. https://nptel.ac.in/courses/106105077/
2. https://nptel.ac.in/courses/106105079/
3. https://www.tutorialspoint.com/artificial_intelligence/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered up to T-1
2	T-2	25	1.5 Hours	Syllabus covered up to T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Applied Artificial Intelligence)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO1	2	2	3	3	2	1	1	1	2	2	2	2	1.91
CO2	3	3	3	3	3	2	1	1	3	2	1	3	2.33
CO3	2	3	2	2	2	2	2	2	2	2	1	2	2.00
CO4	3	3	3	3	2	1	1	1	2	3	2	3	2.25
Average	2.50	2.75	2.75	2.75	2.25	1.50	1.25	1.25	2.25	2.25	1.50	2.50	

Control Systems

COURSE CODE: 18B1WEC531

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

1. To understand procedures for developing mathematical models of physical systems, and related analytical and numerical methods for predicting their behavior.
2. To understand stability of state space models and their controllability and observability in modern automation and control.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	The ability to analyze any physical system using mathematical model.	Familiarity
CO-2	The ability to formulate reduced models for complex systems.	Familiarity
CO-3	The skill to analyze the response of any LTI system.	Assessment
CO-4	The ability to design any system with desired specifications both in time and frequency domain.	Assessment
CO-5	The ability to derive, interpret and solve problems using modern state space control methods for continuous time and discrete time systems.	Usage
CO-6	The skill to apply advance control schemes for various applications.	Usage

Course Contents:

Unit	Contents	Lectures required
1	Introduction to Systems and Control: Open loop and closed loop control systems, components of control system: sensors, actuators, controllers, process, modeling principles of physical systems: electrical, mechanical, thermal and pneumatic systems, effect of feedback on gain, stability, sensitivity and noise, characteristics of transfer function models: poles, zeros, stability and minimal realization, block diagram algebra, signal flow graphs, Mason's gain formula, conversion between block diagram and signal flow graph.	6

2	Response Analysis: Standard test input signals, transient and steady state response: first, second and higher order systems, system design specifications, error analysis: static and dynamic error coefficients, Effect of adding poles and zeroes, Correlation-ship between time and frequency domain specifications	8
3	Stability Analysis: Absolute stability, relative stability, routh-hurwitz, root locus, bode plot, polar plot and Nyquist plot techniques, gain margin and phase margin, constant magnitude loci: M-circles, constant phase Loci: N-circles, nichol's chart. system identification: inverse bode plots. Effect of adding zero to the forward path, effect of adding pole to the forward path.	8
4	Compensator Design: System design specifications, design of compensating networks (Lead, Lag, Lag-Lead) for specified control system performance using root locus and bode plot, concepts and applications of P, PD, PI and PID controllers..	6
5	Linear State Variable Models: Concept of state, state space modeling: SISO and MIMO systems, useful transformations in state space analysis and design, various forms: physical variable form, phase variable form, Jordan canonical form, solution of state equations, computation of state transition matrix: Laplace method, power series method and Cayley Hamilton method, derivation of transfer function from State variable model, decomposition of transfer function: direct decomposition, cascade decomposition, parallel decomposition, characteristics of linear state variable models, natural and forced responses, determination of controllability and observability of a control system using Kalman and Gilbert tests..	8
6	Advanced Control Schemes: Control systems with multiple loops- cascade control, selective control systems: override control, split range control, feed-forward and ratio control, adaptive and inferential control systems.	6
Total lectures		42

Suggested Text Book(s):

1. Benjamin C. Kuo: Automatic Control Systems, 9th Ed., Prentice Hall of India, 2014.
2. Nagrath & Gopal: Control System Engineering, 6th Ed., New Age International Pvt Ltd, 2018.
3. Stephanopoulos, G.: Chemical Process Control, 1st Ed., Prentice Hall of India, 2008.

Suggested Reference Book(s):

1. K. Ogata: Modern Control Engineering, 5th Ed., Prentice Hall India Learning Private Limited, 2010.
2. Norman S. Nise: Control Systems Engineering, 6th Ed., John Wiley & Sons Inc, 2010.
3. Richard C Dorf, Robert H Bishop: Modern Control Systems, 12th Ed., Pearson Edu Pearson, 2014.

Other useful resource(s):

1. Link to NPTEL course contents: https://onlinecourses.nptel.ac.in/noc18_ee41/preview

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (3) - 10 Quizzes (3) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Control Systems)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO1	3	2	2	2	2	1	2	1	1	1	1	2	1.67
CO2	3	2	1	3	2	1	1	1	1	1	1	2	1.58
CO3	3	2	1	3	2	1	1	1	1	1	1	2	1.58
CO4	3	3	2	1	2	1	1	1	1	1	1	2	1.58
CO5	3	3	3	1	2	1	1	1	2	1	1	2	1.75
CO6	3	2	2	2	3	1	1	1	1	1	1	2	1.67
Average	3.00	2.33	1.83	2.00	2.17	1.00	1.17	1.00	1.17	1.00	1.00	2.00	

Microwave Components and Devices

COURSE CODE: 18B1WEC532

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

1. To learn the basic operating principles of microwave components.
2. To have a strong foundations in microwave measurements.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	To understand the basic knowledge of microwave sources.	Familiarity
CO-2	To have a complete knowledge about the wave guide components and their applications in microwave systems.	Assessment
CO-3	To understand and gain knowledge of different active devices and their working principles.	Familiarity
CO-4	To understand and gain thorough knowledge of microwave measurements.	Usage

Course Contents:

Unit	Contents	Lectures required
1	Microwave Sources: Microwave transmission lines, Klystron amplifier design and operation, reflex klystron and TWT amplifier and its gain calculations.	10
2	Microwave waveguides: Parallel plate wave guides, rectangular wave-guides, cylindrical wave-guides, resonators.	10
3	Microwave components: Directional coupler, E-plane Tee, H-plane Tee, Magic Tee, Microwave circulators, Microwave isolators, Microwave attenuators, microwave phase shifters, microwave impedance matching circuits.	10
4	Microwave Devices: Principles of microwave transistor, microwave FET, Gunn oscillators, IMPATT diode, TRAPATT Diode, BARITT diode, PIN diode, Tunnel diode.	6

5	Network analysis and Microwave Measurements: Power measurement, frequency measurement, impedance measurement and VSWR measurement. Scattering parameters and SFG models	6
Total lectures		42

Suggested Text Book(s):

1. Samuel Y. Liao, "Micro wave Devices and Circuits", 3rd Ed., Pearson education, 2003.
2. R. E. Collin, "Foundations for microwave Engineering", 2nd Ed., Tata McGraw Hill, 1992.

Suggested Reference Book(s):

1. Annapurna Das, Sisir.K.Das, "Microwave Engineering", 1st Ed., Tata McGraw Hill, 2000.
2. Pozar, David M. "Microwave engineering", 4th Ed., John Wiley & Sons, 2009.

Other useful resource(s):

1. Link to topics related to course: https://nptel.ac.in/courses/108101112/1 to 12

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered up to T-1
2	T-2	25	1.5 Hours	Syllabus covered up to T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Microwave Components and Devices)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO1	2	2	2	2	2	1	1	1	2	2	2	1	1.7
CO2	2	3	3	3	3	1	1	1	2	2	2	1	2.0
CO3	2	2	2	2	3	1	1	1	2	2	2	1	1.8
CO4	2	3	3	3	2	1	1	1	2	3	2	1	2.0
Average	2	2.5	2.5	2.5	2.5	1.0	1.0	1.0	2.0	2.25	2.0	1.0	

Neural Networks

COURSE CODE:

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

1. To understand the fundamental theory and concepts of neural networks, neuro-modeling, several neural network paradigms and its applications
2. Expose the students to neural network applications and develop the skills for engineering design

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Comprehend the fundamental theory and concepts of neural networks	Familiarity
CO-2	Assess the power and usefulness of artificial neural networks and identify different neural network architectures, algorithms, applications and their limitations	Assessment
CO-3	Understand appropriate learning rules for each of the architectures and learn several neural network paradigms and its applications	Assessment
CO-4	Reveal different applications of these models to solve engineering and other problems as pattern matching, control, optimization, and other areas.	Usage

Course Contents:

Unit	Contents	Lectures required
1	Introduction to neural networks: Artificial Neural Networks (ANN) and their biological roots and motivations. Comparison Between Artificial and Biological Neural Networks, Applications of Neural network. Network Architecture, Taxonomy of neural networks: feed forward and recurrent networks.	5

2	Learning process: Types of learning, Error Correction learning, Memory based learning, Boltzmann learning, Credit Assignment Problem. Learning paradigms, supervised and unsupervised learning laws . Learning Laws : Hebb's rule, Delta rule, Widrow - Hoff (The Least-Mean-Square) learning rule, Correlation learning rule, instar and outstar learning rules, Competitive learning, Learning Tasks.	10
3	Supervised learning: The Perceptron and its learning law, Classification of linearly separable patterns, Multi-Layer Perceptron, Supervised Learning, Back-Propagation Learning law. Feed forward networks, Recurrent Networks. Radial basis function Neural Networks, Memory based learning, Boltzmann learning.	11
4	Unsupervised learning: Winner takes-all Networks, Competitive Learning, Kohonen's Self organizing Maps, Self-organizing Feature-Mapping Algorithm, Properties of SOM algorithms, Examples of Feature Maps, Applications and Adaptive Resonance Theory.	8
5	Adaptive Resonance Theory: Introduction, Formulation, Stability – Plasticity Dilemma, Competitive Learning models, applications.	3
6	Applications of NN: Classification, Function approximation and pattern recognition problems. Solving Optimization Problems, Solving Traveling Salesman Problems, Application in Handwritten Character Recognition, Biomedical, Communication, and Healthcare.	5
Total lectures		42

Suggested Text Book(s):

1. Simon Haykin, "Artificial Neutral Networks" Pearson, 2nd Ed., 2008
2. Yegna Narayanan, "Artificial Neural Networks" Prentice-Hall of India, 2nd Ed., 2010
3. S.N.Sivanandam, S.N Deepa, "Principles of Soft Computing" Wiley, 3rd Ed., 2019

Suggested Reference Book(s):

1. L. Fausett, "Fundamentals of Neural Networks: Architectures, Algorithms, and Applications", Prentice-Hall, 1st Ed., 1993.
2. Jack M. Zurada, "Introduction to Artificial Neural Systems", PWS Publishing Co., Boston, 3rd Ed., 2002.

Other useful resource(s):

Link to NPTEL course contents

1. http://nptel.ac.in/courses/117105084/
2. http://nptel.ac.in/courses/106105079/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered up to T-1
2	T-2	25	1.5 Hours	Syllabus covered up to T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Neural Networks)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO1	3	3	2	2	3	2	1	1	1	2	3	3	1.92
CO2	3	3	3	3	3	2	1	1	1	2	2	3	2.00
CO3	3	3	3	3	3	2	1	1	1	2	2	3	2.08
CO4	3	3	3	3	3	3	3	2	3	3	3	3	2.58
Average	3	2.25	2.75	2.75	3	1.75	1.5	1	1	2.25	2.25	2.25	2.15

Embedded Systems

COURSE CODE:

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

To learn about the embedded system application areas, design challenges, design and development methodology, tools used for embedded system design, embedded system integration and testing.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Understand various components of embedded system, design challenges and design metrics	Familiarity
CO-2	Learn about embedded system programming through 8051 microcontroller, programming and I/O interfacing	Usage
CO-3	Comprehend RISC architecture, programming of ARM and PIC microcontrollers	Usage
CO-4	Know about embedded system design and development methodology, tools and languages used for embedded system design	Usage
CO-5	Learn about integration and testing of embedded systems	Assessment

Course Contents:

Unit	Contents	Lectures required
1.	Introduction: Embedded systems overview, Classification, Application areas, Design challenges – real-time execution, physical size, power consumption, multirate operation. Design metrics – time-to-market, unit cost, performance.	4
2.	Typical Embedded System: Core of the embedded system, Sensors and actuators, Communication interface, Embedded firmware	6
3.	8051 Microcontroller: 8051 Architecture, timers and interrupts, Special function registers, Program/ data memory, addressing modes. instruction set, interrupts,	8
4.	ARM Processor Fundamentals and Architectures, ARM Instruction Set, PIC Microcontroller and its Architecture.	10

5.	Design and Development of Embedded product: Analog Electronic Components, Digital Electronic Components, Electronic design automation tools, Embedded firmware design approaches, Embedded firmware development languages	8
6.	Integration and testing of embedded hardware and firmware, Embedded system development environment, Product enclosure design and development, Embedded product development life cycle, Trends in embedded industry	6
Total lectures		42

Suggested Text Book(s):

1. Frank Vahid and Tony Givargis, "Embedded system design: A unified Hardware/Software introduction,"3rd Ed., Wiley 2014
2. Shibu K. V, "Introduction to Embedded Systems," 2nd Ed., McGraw Hill 2017

Suggested Reference Book(s):

1. Steve Furber, "ARM System-on-Chip Architecture," 2nd Ed., Pearson, 2012
2. Tim Wilmshurst, "Designing Embedded Systems with PIC Microcontrollers: Principles and Applications," 2nd Ed., Newnes, 2009
3. Steven F Barrett and Daniel J Pack, "Embedded Systems Design and Applications with the 68HC12 and HCS12," 1st Ed., Pearson 2012
4. Kenneth Ayala, "The 8051 microcontroller," 3rd Ed., Thomson, 2005

Other useful resource(s):

Link to NPTEL course contents

1. https://nptel.ac.in/courses/108105057/
2. https://nptel.ac.in/courses/108102045/
3. https://nptel.ac.in/courses/106105159/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Embedded Systems)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO1	2	X	2	1	2	X	X	X	X	X	3	1	0.92
CO2	3	3	3	2	3	2	X	X	2	3	X	3	2.00
CO3	3	2	3	2	3	2	X	X	1	2	X	2	1.67
CO4	3	2	3	2	3	2	X	X	1	X	X	2	1.50
CO5	3	2	3	2	3	2	X	X	X	X	X	2	1.42
CO6	3	2	3	2	2	3	X	X	2	2	1	1	1.75
Average	2.83	1.83	2.83	1.83	2.67	1.83	0.00	0.00	1.00	1.17	0.67	1.83	

IoT and Application

COURSE CODE : 20P11EC111

COURSE CREDITS: 03

CORE/ELECTIVE: Core

L-T-P:

Pre-requisite: None

Course Objectives:

1. Learn the interconnection and integration of the physical world and the cyber space.
2. Able to design & develop IOT Devices.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Understand the concepts of Internet of Things	Familiarity
CO-2	Able to realize the revolution of Internet in Mobile Devices, Cloud & Sensor Networks ·	Familiarity
CO-3	Able to understand building blocks of Internet of Things and characteristics.	Assessment
CO-4	Analyze basic protocols in wireless sensor network	Assessment
CO-5	Design IoT applications in different domain and be able to analyze their performance	Usage
CO-6	Implement basic IoT applications on embedded platform	Usage

Course Contents:

Unit	Contents	Lectures required
1	Introduction to IoT,Sensing, Actuation , Basics of IoT Networking	**7**
2	Connectivity Technology, Sensor Networks, UAV Networks, Machine to Machine Communication	**12**
3	Interoperability in IoT, Introduction to Aurdino, Integration of Sensor and Actuator with Aurdino, Introduction to Raspberry Pi, Implementation of IoT with Raspberry Pi	**11**

4	Smart Cities and Smart Home, Connected Vehicles, Smart Grid, Industrial Internet of Things	**9**
5	Case Studies: Agriculture, Case Study: Healthcare, Case Study-Activity Monitoring	**4**
Total lectures		**42**

Suggested Text Book(s):

1. The Internet of Things: Enabling Technologies, Platforms, and Use Cases", by Pethuru Raj and Anupama C. Raman (CRC Press)
2. "Internet of Things: A Hands-on Approach", by Arshdeep Bahga and Vijay Madisetti (Universities Press)

Suggested Reference Book(s):

1. The internet of things, Samuel Greengard, 2020 The MIT Press
2. Internet of Things: Architectures, Protocols and Standards 1st Edition

Other useful resource(s):

1. https://nptel.ac.in/noc/courses/noc19/SEM1/noc19-cs31/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (3) - 10 Quizzes(3) -10 Attendance – 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (IoT and Application)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	2	2	2	2	1	2	1	1	1	1	2	**1.67**
CO-2	3	2	1	3	2	1	1	1	1	1	1	2	**1.58**
CO-3	3	2	1	3	2	1	1	1	1	1	1	2	**1.58**
CO-4	3	3	2	1	2	1	1	1	1	1	1	2	**1.58**
CO-5	3	3	3	1	2	1	1	1	2	1	1	2	**1.75**
CO-6	3	2	2	2	3	1	1	1	1	1	1	2	**1.67**
Average	**3.00**	**2.33**	**1.83**	**2.00**	**2.17**	**1.00**	**1.17**	**1.00**	**1.17**	**1.00**	**1.00**	**2.00**	

Low Power CMOS VLSI Circuit Design

COURSE CODE: 20P11EC112

COURSE CREDITS: 3

CORE/ELECTIVE: PhD

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

1. Students shall understand the fundamentals of power dissipation due to various reasons
2. Students shall be able to design and test low voltage, low power CMOS circuits specifically low power SRAM cells.
3. Students shall learn to use energy recovery techniques and understand the impact of algorithmic techniques on overall power optimization in CMOS circuits

Course Outcomes :

S.No.	Course Outcomes	Level of Attainment
CO-1	Understand the fundamentals of power dissipation in microelectronic devices.	Familiarity
CO-2	Understand and estimate power dissipation due to switching, short circuit, sub threshold leakage and diode leakage current.	Familiarity
CO-3	To be able to design and test low-voltage CMOS circuits	Assessment
CO-4	Understand power-conscious logic and high-level synthesis of circuits.	Assessment
CO-5	Understand low-power static RAM architecture.	Usage
CO-6	To be able to perform low-energy computing using energy recovery techniques.	Usage
CO-7	Understand software power estimation and optimization	

Course Contents :

S. No.	Contents	Lecture Required
1.	Introduction: Physics and source of power dissipation in CMOS FET devices,Need for low power VLSI chips, Emerging low power approaches.	2

2.	Device and Technology Impact on Power Estimation: Dynamic dissipation in CMOS, Effect of and on speed, Constraint on reduction, Transistor sizing and gate oxide thickness, Impact of technology scaling.	7
3.	Low power circuit techniques: Power consumption in circuits, High capacitance nodes, Capacitive power estimation, Switching activity reduction.	2
4.	Synthesis for Low Power: Power estimation techniques, Power minimization techniques, Logic synthesis, Verification, High level synthesis. General purpose methods for power optimization-Partitioning, Floor planning and pin assignment, Routing.	8
5.	Design and Test of Low-Voltage CMOS circuits:Deep sub-micron low voltage CMOS circuit, Multiple VT and dynamic VT, Circuit techniques-MTCMOS, VTCMOS, DTMOS, SCMOS, SOI implementation.	8
6.	Low-Power Static Ram Architectures and Clock Distribution:Power dissipation in SRAM architecture,Power dissipation in clock distribution, Low power SRAM circuits, Zero skew and tolerable skew, Single driver vs Distributed buffers, Power reduction in clock networks.	9
7.	Low-Energy Computing Using Energy Recovery Techniques: Basic energy recovery computing system, Retractile logic, Reversible pipelines, High-performance approaches.	4
8.	Software Design for Low Power: Software power optimization techniques, Power dissipation influenced by software.	2
	Total	42

Suggested Text Book(s) :

1. Jan M. Rabaey and Massoud Pedram, Low Power Design Methodologies, springer, 2009.
2. Kaushik Roy and Sharat C. Prasad, Low-Power CMOS VLSI Circuit Design, Wiley-Interscience, 1st Ed, 2009.

Suggested Reference Book(s):

1. Wolfgang Nebel, Jean P. Mermet, Low Power Design in Deep Sub-micron Electronics, springer, 1st Ed.
2. David A. Hodges, Horace G. Jackson, Analysis and Design of Digital Integrated Circuits in Deep Sub-micron Technology, McGraw Hill, 3rd Ed.

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1

2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (3) - 10 Quizzes(3) -10 Attendance – 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Low Power CMOS VLSI Circuit Design)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	2	2	2	2	1	2	1	1	1	1	2	**1.67**
CO-2	3	2	1	3	2	1	1	1	1	1	1	2	**1.58**
CO-3	3	2	1	3	2	1	1	1	1	1	1	2	**1.58**
CO-4	3	3	2	1	2	1	1	1	1	1	1	2	**1.58**
CO-5	3	3	3	1	2	1	1	1	2	1	1	2	**1.75**
CO-6	3	2	2	2	3	1	1	1	1	1	1	2	**1.67**
Average	**3.00**	**2.33**	**1.83**	**2.00**	**2.17**	**1.00**	**1.17**	**1.00**	**1.17**	**1.00**	**1.00**	**2.00**	

Department of Electronics and Communication Engineering

PhD Course

Reconfigurable Computing

COURSE CODE: 19P1WEC101

COURSE CREDITS: 3

CORE/ELECTIVE: PhD

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives

Students will gain fundamental knowledge and understanding of principles and practice in reconfigurable architecture and computing through class lectures and discussions, and reading assignments.

Course Outcomes :

S.No.	Course Outcomes	Level of Attainment
CO-1	Understand the concept of reconfigurable computing and FPGA architectures.	Familiarity
CO-2	Understand and explore the various FPGA computing platforms in terms of design tools.	Familiarity
CO-3	The student will be able to formulate the specialized arithmetic circuits and powerful techniques like pipelining and unfolding	Assessment
CO-4	Analyze the coarse-grained and fine grain configurability for performance enhancement using multi-FPGA systems.	Assessment
CO-5	To be able to create new designs and analyze advanced techniques such as fault tolerance and partial reconfiguration.	Usage
CO-6	Design, analyze and apply reconfigurable computing in various applications for optimization.	Usage

Course Contents :

S. No.	Contents	Lecture Required
1.	Introduction: Test Process and Test Economics, Functional vs Structural Testing Defects, Errors, Faults and Fault Modelling (mainly stuck at fault modelling),	8

	Fault Equivalence, Fault Dominance, Fault Collapsing and Checkpoint Theorem.	
2.	FPGA Architectures and Algorithms of Reconfigurable Computing : General overview of computing models, Basic RC concepts, Performance, power, size, and other metrics, RC devices and architecture – fine grained and coarse grained, integration into traditional systems, FPGA computing platforms, Design tools and languages: HDLs, Synthesis, PAR, HLL and HLS, RC application development, domains and case studies, Special topics in RC: Middleware, Fault tolerance, Partial reconfiguration, device characterization.	8
3.	Implementing Applications with FPGAs : Strengths and Weaknesses of FPGAs, Time to Market, Development Time, Power Consumption, Debug and Verification, FPGAs and Microprocessors, Application Characteristics and Performance, Computational Characteristics and Performance, I/O and Performance, General Implementation Strategies for FPGA-based Systems, Configure-once, Runtime Reconfiguration, Summary of Implementation Issues, Implementing Arithmetic in FPGAs, Fixed-point Number Representation and Arithmetic, Floating-point Arithmetic, Block Floating Point, Constant Folding and Data-oriented Specialization	9
4.	Defect and Fault Tolerance : Defects and Faults, Defect Tolerance, Substitutable Resources, Yield, Defect Tolerance through Sparing, Defect Tolerance with Matching, Transient Fault Tolerance, Feedforward Correction, Rollback Error Recovery, Lifetime Defects, Detection, Repair, Configuration Upsets,	8
5.	Reconfigurable Computing and Nanoscale Architecture Trends in Lithographic Scaling, Bottom-up Technology, Nanowires, Nanowire Assembly, Crosspoints, Challenges, Nanowire Circuits, Wired-OR Diode Logic Array , Restoration, Statistical Assembly, nanoPLA Architecture, Basic Logic Block, Interconnect Architecture, Memories, Defect Tolerance, Design Mapping, Density Benefits, Nanoscale Design Alternatives, Imprint Lithography, Interfacing	9
	Total	42

Suggested Text Book (s) :

1. N. Nedjah , C. Wang, Reconfigurable and Adaptive Computing: Theory and Applications, Chapman and Hall/CRC, 1st Ed., 2018.
2. S. Hauck and A. DeHon, Reconfigurable Computing: The Theory and Practice of FPGA-Based Computation, Elsevier, 1st Ed., 2008.
3. M. B. Gokhale and P.S. Graham, Reconfigurable Computing: Accelerating Computation with Field Programmable Gate Arrays, Springer, 1st Ed., 2005.

Suggested Reference Book(s):

1. R. Cofer and B.F. Harding, Rapid System Prototyping with FPGAs: Accelerating the Design Process, Newnes, 1st Ed., 2005
2. C. Maxfield, The Design Warrior's Guide to FPGAs, Newnes, 1st Ed., 2004
3. C. Bobda, Introduction to Reconfigurable Computing: Architectures, Algorithms and Applications, Springer, 1st Ed., 2007.
4. P. Lysaght and W. Rosenstiel, New Algorithms, Architectures and Applications for Reconfigurable Computing, Springer, 1st Ed., 2005.

Other useful resource(s):

1. http://www.secs.oakland.edu/~llamocca/Fall2015_ece495.html

SYLLABI OF ELECTIVES FOR M.Sc - BIOTECHNOLOGY

DEPARTMENT OF BIOTECHNOLOGY & BIOINFORMATICS
Molecular and Clinical Diagnostics

COURSE CODE: XXXXXXXX
COURSE CREDITS: 3
COURSE : ELECTIVE
L-T-P: 3-0-0

Prerequisites: Basic Biology

Course Objective:

This course aims to familiarize the students with the principles & applications of the latest state-of-the-art bio-molecular technologies with specific reference to Nucleic Acids and Proteins used in Health, Medical Research, various and clinical settings and Forensic laboratories the world over. This course covers both theory and practical aspects of modern instrumentation used for analysis in biological research

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	To understand the basic concepts of diagnostics in research and clinical settings.	Familiarity
CO-2	To learn the basics of various DNA based diagnostic methods, quality control and applications.	Usage
CO-3	Able to Understand basic instrumental principles involved in the operation of mass spectrometers, infrared spectrometers, and nuclear magnetic resonance spectrometers.	Usage
CO-4	To learn the basics of various Antigen – Antibody based diagnostic methods, with their comparative advantage and limitations.	Usage
CO-5	To understand and learn various label based diagnostic methods, their applications in research and pathological settings.	Usage

Course Contents:

Unit	Contents	No. of Lectures
1	**Introduction to Clinical Diagnostics:** Philosophy and general approach to clinical specimens, Sample collection (Blood, urine, spinal fluid, synovial fluid, amniotic fluid) - method of collection, preservation, transport and processing of samples. Diagnosis – disease altered state, prognosis, direct and indirect, concept of antigen and antibody.	**3**
2	**PCR based Clinical Diagnostics:** Nucleic acid extraction from clinical samples, quantization, digestion, hybridization, Amplification by PCR (Inverse PCR, Multiplex PCR, Nested PCR, Hot-start, applications and limitations). Validation and quality control of polymerase chain reaction methods used for the diagnosis of infectious diseases.	**5**
3	**Antigen-Antibody Interaction based Diagnostic Techniques:** Hybridoma technology, Concept of monoclonal vs polyclonal antibodies, specific, Theories of antigen-antibody interaction. Precipitation based diagnostic methods – radial diffusion, double diffusion, immunoelectrophoresis, rocket Immunoelectrophoresis, 2-D Immunoelectrophoresis, Immunoprecipitation. Agglutination - principle,	**7**

	ABO blood typing, latex agglutination, agglutination inhibition.	
4	**Radio labeling Techniques for Diagnostics:** Detection and measurement of different types of radioisotopes normally used in biology, incorporation of radioisotopes in biological tissues and cells, molecular imaging of radioactive material, safety guidelines. Imaging based Techniques – MRI, PET.	**7**
5	**Biophysical Methods for Diagnostics:** Molecular analysis using UV/visible, fluorescence, circular dichroism, NMR and ESR spectroscopy. Molecular structure determination using X-ray diffraction and NMR, Types of mass spectrometry and surface plasma resonance methods.	**8**
6	**Microscopic techniques for visualization and localization of cells and antigens:** Visulization of cells and subcellular components by light microscopy, resolving powers of different microscopes, microscopy of living cells, scanning and transmission microscopes, different fixation and staining techniques for EM, freeze-etch and freeze- fracture methods for EM.	**4**
7	**Label Based Diagnostic Methods** - Radioimmuno Assay, western blot, ELISPOT, ELISA – types, designing, Immunohistochemistry, In situ localization by techniques - FISH and GISH, Immunofluorescence, Flow Cytometry – Principle, components, and applications. FACS.	**8**

Recommended Books:

1. Kindt, T.J., Goldsby, R.A. and Osborne, B.A. (2007). Kuby Immunology .W.H. Freeman and Co., New York, 7th Ed.
2. Kenneth Murphy, Charles A Janeway, Paul Travers and Mark Walport (2007) Immunobiology Garland Science, 8th Ed.
3. Abbas AK, Lichtman AH and Pillai S (2001) Cellular and Molecular Immunology; Elsevier, USA, 7th Ed.
4. Roit, I. (2012). Essential Immunology. Blackwell Scientific Publications, Oxford, 12th Ed.
5. Primrose SB, Twyman RM and Old RW (2002) Principle of gene manipulation. Wiley-Blackwell, UK, 6th Ed.
6. Chakravarty AK (2006) Immunology and Immunotechnology. Oxford University Press, 1st Ed.
7. Practical Biochemistry, Principles and Techniques - Keith Wilson and John Walker (2009)

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment, Quizzes & Attendance

DEPARTMENT OF BIOTECHNOLOGY & BIOINFORMATICS

Course Title	**Quality Control and Quality Assurance**	**(Elective Course)**
Course Code	xxxxxxxx	
Course Credit	3	
Course Coordinator	Dr. Gopal Singh Bisht	

L	T	P
3	0	0

Course Objectives

The Objective of the course is to make the student aware of quality control techniques and process for routine analysis of various biotech and pharmaceutical products. They will learn design of QC laboratory for chemical, instrumental and microbiological analysis.

Course Assessment

Assessment	Max. marks	Duration	Course Covered
T1 Test	15	1 hr.	Unit 1-2
T2 Test	25	1.5 hrs.	Unit 1,2,3,4
End Term Test	35	2 hrs.	Whole Syllabus
Teacher Assessment (Based on Assignments, quizzes etc.)	25	Whole Semester	Inform class time to time
Total	**100**		

Course Outcomes

CO I	To understand concept of quality control & importance of quality control of various biotechnological products
CO II	Able to design and prepare quality sheets for various process
CO III	Able to learn quality control guidelines for maintaining various equipment and process used in biotech industry
CO IV	To understand various validation process involved in R& D industry
CO V	To be able to use quality tools to prepare process control chart

Unit no.	Topics Covered	Contact Hrs.
1	Introduction of Quality Control & Quality Assurance, Evaluation of quality control, Using Quality Assurance for the Best Results; The Role of Inspection in Quality Control, Collecting Your Quality Data	4
2	Quality Models in business, Six Sigma Concept, Six Sigma tools, Continuous improvements and its applications, Ten Steps for Incorporating Quality into a New Product and/or Process; Quality Management: Practices, Tools, and Standards Stability Studies, ICH Guidelines, WHO Guidelines Good Practices in QC laboratory, Schedule L1, standardization of reagents, labeling of reagents, control, QA Lot release, non-conforming material review, failure review QC Lot	18

	release testing –chemical assays & bioassays ,validation for quality control QC Raw material testing, in-process testing, validation support QA Audit procedures and vendor certification Handling out-of-specification results	
3	Good Practices in QC laboratory, Schedule L1, standardization of reagents, labeling of reagents, control, Design of QC laboratory for chemical, instrumental and microbiological analysis. Quality Control techniques for routine analysis with HPLC: Quality control aspects of Pharmaceuticals and Food products, Quality control aspects of Bioactive natural products, QC Monoclonal antibody products QC rDNA products ,	12
4	Statistics Process control: control chart for variable and attributes, P charts C charts,Quality control laboratory: Environmental monitoring, setting of limits and its evaluation. Control of contamination and cross contamination. Contract manufacturing and analysis	8
	Total	42

TEXT BOOKS

1	Fundamentals of Quality control and improvement by Ämitav Mitra A John Wiley & Sons, Inc., Publication
2	Good Manufacturing Practices for Pharmaceuticals by Sidney H Willig, Marcel and Dekker
3	Quality Assurance in Environmental Monitoring by P. Quevauviller, Wiley VCH
4	Bioactive Natural Products: Quality Control & Standardization by V.K.Gupta, s.c. Taneja and B.D. Gupta, Studium Press LLC, U.S.A.

DEPARTMENT OF BIOTECHNOLOGY & BIOINFORMATICS

Nanobiotechnology: Principles and Applications

Course Code:
Course Credits: 3
Core / Elective: Elective
L-T-P: 3-0-0

Pre-requisite: Basic of Physics, Chemistry and Biology

Course Objectives:

- Introduction to Nanomaterial and various material used for obtaining nano-materials
- Learn various approaches or methods used for nanomaterial synthesis.
- To learn various analytical techniques used for nanomaterial characterization.
- Learn various applications of nanomaterial in health care, agriculture and environmental monitoring

Course Outcomes

S. No.	Course Outcomes	Level of Attainment
CO I	Introduction to nano-biotechnology and develop an understanding of the fundamental properties of matter at nanoscale.	Familiarity
CO II	Identify the principles of processing and manufacturing of nanomaterials.	Assessment & Technical
CO III	Fundamental understanding and characterization of nanomaterials.	Assessment & Technical
CO IV	Fundamental understanding of biologically inspired nanomaterial and application.	Usage
CO V	Identify the applications of nanomaterial in biomedical sciences.	Usage

Course Contents:

Unit		Contents	Lectures
1	Introduction to Nano-Biotechnology	Characteristic length scales. Concepts of nanomaterials and nanostructures .Definition of nano-biotechnology. One dimensional, Two dimensional and Three dimensional nanostructured materials, Quantum Dots shell structures, metal oxides, etc. physical-chemical properties.	4
2	Types of nanomaterials and properties of nanomaterials	Quantum effect, structural and fundamental principles of nano-biotechnology. Stability criteria of nanomaterials for biological applications.	3
3	Method of Preparation and characterization	Nanomaterial synthesis using chemical, Physical and Biological methods. Basic characterization technique e.g. electron microscopy (SEM, TEM), Atomic Force microscopy, Dynamic Light Scattering, Nuclear Magnetic Resonance and Spectroscopic technique	9

4	Biologically Inspired Nanomaterial for Biomedical Applications	Structurally Inspired Materials like, Liposomes, Virosomes, Polymerosome and functionally inspired nanomaterial such as muscle adhesive protein	7
5	Nanostructure in Biological Detections	Use of nanomaterials (quantum dot, gold nanoparticles, silver nanoparticles) in fluorescence detection, surface Plasmon based detection and electrochemical detection	9
6	Applications	Use of nanomaterials in drug delivery, Tissue engineering and environmental protection	10
	Total Number of Lectures		**42**

Methodology
The course will be covered through lectures. Apart from discussions on topics covered in lectures, assignments and analytical will also be given

TEXT BOOKS

1	C. N. R. Rao, A. Muller, A. K. Cheetham (Eds), The chemistry of nanomaterials: Synthesis, properties and applications, Wiley VCH Verlag Gmbh & Co, Weinheim, 2004.
2	P. Boisseau, P. Houdy, M. Lahmani, Nanoscience: Nanobiotechnology and Nanobiology
3	Nanomaterials for Biosensors, Cs. Kumar, Wiley – VCH, 2007
4	G.Cao, Naostructures and Nanomaterials: Synthesis, properties and applications, Imperical College Press, 2004.

REFERENCE BOOKS

1	C. A. Mirkin and C. M. Niemeyer. Nanobiotechnology - II more concepts and applications. (2007) -Wiley VCH.
2	D.A Phoenix, W. Ahmed, Nanobiotechnology, One Central Press Ltd, UK
3	L. Filipponi, D. Sutherland, Nanotechnologies: Principles, Applications, Implications and Hands-on Activities.Directorate- European commission

Other useful resource(s): Link to NPTEL course contents

- https://nptel.ac.in/courses/118107015/
- https://onlinecourses.nptel.ac.in/noc17_bt17/preview
- http://videos.gitam.edu/nptel/nano.html

Evaluation Scheme:

S. No.	Exam	Marks	Duration	Coverage/Scope of Examination

1	T-1	15	1 Hour	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Quiz-1 -10 Quiz-2 -10 Attendance -5

DEPARTMENT OF BIOTECHNOLOGY & BIOINFORMATICS
Cell Signaling

COURSE CODE:
COURSE CREDITS: 3
CORE/ELECTIVE: ELECTIVE
L-T-P: 3-0-0

Pre-requisite: Cell Biology, Molecular Biology, Biochemistry

Course Objective:

Objective of this course is to enable the students to have the understanding of the basics of the cellular signaling. This course will impart knowledge regarding the communication between the cells and how the signaling process is involved in the various basic processes of the cells. The course will also impart knowledge to the students about signaling processes in the normal physiology and various pathological conditions. The Course would be extremely beneficial to the students if they want to further pursue a career in higher studies/research.

Topics include the pathways by which cells respond to extracellular signals such as growth factors and the mechanisms by which extracellular signals are translated into alterations in the cell cycle, morphology, differentiation state, and motility of the responding cells. Stress pathways regarding how the cells respond to survive the stress or induce their own death.

Course Outcomes

S. No.	Course Outcomes	Level of Attainment
CO-1	The students will have basic knowledge about the signaling pathways.	Familiarity
CO-2	The students will understand the need of the signaling molecules and the consequences on their absence.	Assessment
CO-3	Students will understand the function of specific anabolic and catabolic pathways and how these pathways are controlled and interrelated. They will understand various signaling pathways and signaling molecules.	Assessment
CO-4	Students will be able to apply the knowledge of signal transduction in normal physiology as well as in pathophysiological conditions.	Usage

Unit	Contents	No. of Lectures
1	Regulation of transcription and translation. Signal transduction: definition, signals, ligands and receptors. Endocrine, paracrine and autocrine signaling. Cyclic nucleotides and G proteins, G protein signaling, Second Messengers and Protein Kinases.	4
2	Receptors and signaling pathways: cell signaling, cell surface receptors. G Protein coupled receptors-structure, mechanism of signal transmission, regulatory GTPases. Cytokines and chemokines. Signal transmission via Ras-Erk and other MAPKs, Jak-STAT, Hedgehog; Wnt, NF-kB, etc.	8
3	Reactive oxygen species, Nitric oxide, free radicals, etc. Programmed Cell Death: intrinsic and extrinsic triggers and the pathway involved	5

4	Signal Transduction by Ions: Functional role of ions such as Calcium, Zinc, etc their channels and transporters and intracellular signaling.	6
5	Signaling at Synapses: Nerve impulse transmission –Nerve cells, synapses, reflex arc structure, Resting membrane potential, action potential. Neurotransmitters and Their Receptors. Photochemical reaction and regulation of rhodopsin.	8
8	Signal transduction in Health and Disease: Cancer, Neurodegeneration, Diabetes, etc. eg. Insulin and the signal transduction cascades it invokes in normal and pathological condition.	6
9	Techniques used to study/elucidate/intervene cell signaling	5
		42

Suggested Text Book(s):

1) Molecular biology- David Freifelder, Narosa Publishing House Pvt. Limited, 2005
2) Biochemistry of Signal Transduction and Regulation. 3rd Edition. Gerhard Krauss, 2003 WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim ISBN: 3-527-30591-2
3) Molecular Biology of the Cell, 4th edition, Bruce Alberts. New York: Garland Science; 2002. ISBN-10: 0-8153-3218-1ISBN-10: 0-8153-4072-9
4) Molecular Cell Biology, 4th edition**,** Harvey Lodish.New York: W. H. Freeman; 2000. ISBN-10: 0-7167-3136-3
5) Principles of cell and molecular biology- Lewis Kleinsmith, 2nd edition, illustrated, HarperCollins, 1995.

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment, Quizzes & Attendance

CO-PO mapping:

CO/PO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2
CO1	3	3	3	2	2	3	3
CO2	3	3	3	2	2	3	2
CO3	3	3	3	2	3	3	2
CO4	3	2	2	2	2	3	3
Average	**3**	**2.75**	**2.75**	**2**	**2.25**	**3**	**2.5**

Optical Communication Systems

COURSE CODE: 18B1WEC633

COURSE CREDITS: 2

CORE/ELECTIVE: ELECTIVE

L-T-P: 2-0-0

Pre-requisite: None

Course Objectives:

1. To understand the constituents of the fiber optics communication system .
2. To have an in depth knowledge of practically used optical communication systems

Course Outcomes:

S.No.		Level of Attainment
CO-1	To understand the basics of optical communication systems .	Familiarity
CO-2	To know the principles that govern optical communication systems receiver.	Familiarity
CO-3	To have a deep knowledge about modulation and demodulation techniques used in an optical system.	Assessment
CO-4	The hardware components required to implement optical communication systems.	Assessment
CO-5	To efficiently measure the optical communication system parameters.	Usage

Course Contents:

Unit	Contents	Lectures required
1	**Introduction to Optical fiber communication system:** Review of devices and components used in optical communication systems such as LEDs, Lasers, Photodiodes, connectors and splicer, Power (Link) budget calculations.	4
2	**Receiver performance considerations:** Direct detection Noise, Receiver Noise, Receiver structure, FET preamplifiers, High performance structures	5
3	**Optical fiber systems: I** **Intensity modulation/direct detection**: System design considerations, Digital systems, Digital system planning considerations, Analogue systems ,Distribution systems, Multiplexing strategies.	6
4	**Optical fiber systems: I** **Coherent and phase-modulated:** Basic coherent system, Coherent detection principles, Practical constraints, Modulation formats, Demodulation schemes, Differential phase shift keying, Receiver sensitivities, Multicarrier systems	6
5	**Optical fiber measurements:** Fiber attenuation measurements, Fiber dispersion measurements, Fiber refractive index profile measurements, Fiber cutoff wavelength measurements, Fiber numerical aperture measurements, Fiber diameter measurements, Mode-field diameter for single-mode fiber, Reflectance and optical return loss, Field measurements	7
Total lectures		28

Suggested Text Book(s):

1. Optical Fiber Communications, John M Senior, 3rd Edition, PHI, 2009.
2. Fiber Optic Communication Systems, Govind P. Agarwal, 4th Edition, Wiley, 2010.
3. Fiber Optics and Optoelectronics, R.P. Khare Oxford University Press, 2015

Suggested Reference Book(s):

1. Fiber Optic Communications, S. Kumar and M. J. Deen, Wiley, 2014.
2. Optical Fiber Communications, G. Keiser, 5th Edition, Tata McGraw Hill, 2009.

Other useful resource(s):

1. Link to NPTEL course contents: https://nptel.ac.in/courses/117101002/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Optical Communication Systems)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	1.75
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	2
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	1.75
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	2.08
CO-5	2	3	3	3	2	1	1	1	2	3	2	2	2.08
Average	2	2.6	2.6	2.6	2.4	1	1	1	2	2.4	1.66	2	

Optical Communication Systems Lab

COURSE CODE: 18B1WEC633

COURSE CREDITS: 1

CORE/ELECTIVE: ELECTIVE

L-T-P: 0-0-2

Pre-requisite: None

Lab Course Objective:

To understand the constituents of the fiber optics communication system and optoelectronics and know their functionality

1. Fundamentals of fiber optics and components in a fiber optic system
2. Measurement of connector, bending and fiber attenuation losses.
3. Measurement of Numerical Aperture and Mode Characteristics of Fibers.
4. Investigate the DC Characteristics of LED and PIN Photo diode.
5. Fiber optic Analog and Digital Link Characterization - frequency response (analog), eye diagram and BER (digital)
6. Study on the Variable optical attenuator (VOA)
7. Study on Optical fibre isolator
8. Study on Fiber-based optical switch
9. Wavelength division multiplexing (WDM) principle
10. Study on Principle of EDFA (Erbium-doped Fibre Amplifier)
11. Project work implementation by the student

Suggested Text Book(s):

4. Optical Fiber Communications, John M Senior, 3rd Edition, PHI, 2009.
5. Fiber Optic Communication Systems, Govind P. Agarwal, 4th Edition, Wiley, 2010.

Optical Networks

COURSE CODE: 18B1WEC842

COURSE CREDITS: 2

CORE/ELECTIVE: ELECTIVE

L-T-P: 2-0-0

Pre-requisite: None

Course Objectives:

1. To expose the students to the basic and advanced concepts of optical networks.
2. To make the students aware of different types of optical networks that are used in recent times.

Course Outcomes:

S.No.		Level of Attainment
CO-1	Recognize different basic types of Optical networks	Familiarity
CO-2	To understand the issues in optical network management and survivability	Assessment
CO-3	To get acquainted with single hop and multi hop networks.	Assessment
CO-4	Get acquainted with optical switching.	Usage
CO-5	Get familiar with the recent optical networks used for practical purposes.	Usage

Course Contents:

Unit	Contents	Lectures required
1	**Review of Optical communication system and optical Networks:** Review of SONET and SDH, WDM optical networks and components used in these networks.	4
2	**Control and Management and Network Survivability:** Network Management Functions, Optical Layer Services and Interfacing, Layers within the Optical Layer, Performance and Fault Management, BER Measurement, Protection in SONET/SDH, Protection in the Client Layer, Optical Layer Protection Schemes	7
3	**Single and Multi-hop Networks:** Introduction to single and multi-hop networks, Characteristics of single and multi-hop networks, experimental single hop networks: LAMBDANET, STARNET, SONATA, Rainbow	6
4	**Optical switching:** Optical packet switching basics, slotted and unslotted networks, header and packet format, contention resolution in OPS networks, self routing, examples on OPS node architecture.	6
5	**Optical Access and Metro Network:** Introduction to access network, PON, EPON and WDN EPON: overview, principal of operation, architecture; dynamic wavelength allocation,	5
Total lectures		28

Suggested Text Book(s):

1. Optical Network Series:Biswanath Mukherjee, Springer, 2006.
2. Optical Networks: R.Ramaswami and K.Sivarajan, Â Morgan Kaufmann Publishers, 2nd Edition, 2002.
3. Optical Switching Networks: Mayer & Martin, Cambridge University Press, 2008.
4. Optical Fiber Communications- Principles and Practice by John M Senior, 3rd Edition, Pearson Education India.

Suggested Reference Book(s):

1.Data Communication by Behrouz Â, A Forouzan, Mc Graw Hill, 4th Edition.

2.Optical Switching: Tarek S. El. Bawab, Springer.

Other useful resource(s):

1. http://www.iec.org/online/tutorials/acrobat/opt_net.pdf
2. http://www.pdf-search-engine.com/optical-networking-pdf.html
3. http://www.networktutorials.info/networkhowto/what_is_optical_networking.html
4. http://www.urec.fr/hd/DWDM/ALCATEL/optical_network.pdf

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes(2) -10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Optical Networks)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	1.75
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	2
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	1.75
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	2.08
CO-5	2	3	3	3	2	1	1	1	2	3	2	2	2.08
Average	2	2.6	2.6	2.6	2.4	1	1	1	2	2.4	1.6	2	

Optical Networks Lab

COURSE CODE: 18B1WEC842

COURSE CREDITS: 1

CORE/ELECTIVE: ELECTIVE

L-T-P: 0-0-2

1. Introduction to optiperformer and Optisystems
2. To measure the attenuation : limited fiber length
3. Dispersion measurement and dispersion compensation
4. To investigate the Gaussian pulse propagation
5. To understand the Receiver sensitivity
6. Investigate the L-I curves and spectrum of a FP Laser and observe the effects of different cavity characteristics. Learn to perform parameter sweeps in OptiSystem.
7. Investigate the characteristics of PIN Photodiodes and understand the usage of the Lightwave Analyzer component
8. Investigate the effect of loss on optical system performance and characterize the system with the power budget equation. Use OptiSystem to optimize the fiber length of a communication system.
9. Investigate the method for measuring the BER accurately and the distortions present in coherent modulators.
10. Build a coherent receiver based on the 90 degree optical hybrid and further investigate the QAM format.
11. A project based on optical network using the network simulator.

Suggested Text Book(s):

1. Optical Network Series:Biswanath Mukherjee, Springer, 2006.
2. Optical Networks: R.Ramaswami and K.Sivarajan, Â Morgan Kaufmann Publishers, 2nd Edition, 2002.

REMOTE SENSING AND GEOMATICS

COURSE CODE:

COURSE CREDITS: 3

CORE/ELECTIVE: OPEN ELECTIVE

L-T-P: 3-0-0

Pre-requisites: None

Course Outline:

With development of various hard and soft technologies in last two decades, advanced mapping techniques have evolved. It gives a paradigm shift as conventional surveys are superseded by advanced surveying techniques, which are not only accurate and flexible but require minimum time to acquire large amount of 3D data. Therefore, these techniques have been extensively used in many areas of engineering by students, researchers, and industries. On the other hand, the fundamental concepts of most of the advanced surveying techniques are not clear to all users. This course will introduce the students to the state-of-the-art concepts and practices of modern surveying, remote sensing and GIS. It starts with the fundamentals of surveying and remote sensing and GIS and subsequently advanced methods will be covered.

Course Objectives:

1. To familiarize students with the modern methods of collection and processing of topological data.
2. To introduce the students to the fundamentals of satellite-based surveying.
3. To enable the students to carry out detailed survey of any location using satellite data and advanced image processing techniques.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Understanding of the need and concepts of modern surveying	Understanding
CO-2	Application of Remote Sensing and GIS to collect topological data.	Application
CO-3	Analysis of satellite data using digital image processing to get details of topology	Analysis

Course Contents:

Unit	Contents	Lectures Required
1.	**Fundamentals of Remote Sensing –** Principle and Components, Energy Source and Interactions, EM Radiation and EM Spectrum, Elements of Remote Sensing, Platforms, Types of RS **Photogrammetry –** Classification, Aerial photographs, Aerial cameras, Relief Displacement, Flight planning, Global Positioning System **Image Interpretation –** Principles, interpretation keys, Elements of special and spectral Identification, Generation of thematic maps, Radar image interpretation	**10**
2.	**Digital Image Processing –** Image rectification, enhancement, transformation and classification, data merging and GIS Integration, Geometric corrections Co-registration of Data, Ground Control Points (GCP) Atmospheric corrections, Solar illumination corrections, Concept of color, Color composites	**9**
3.	Satellites and orbits, Polar orbiting satellites, Spectral, radiometric and spatial resolutions, Temporal resolution of satellites Multispectral, thermal and hyper spectral sensing., Some remote sensingsatellites and their features	**5**
4.	**Fundamental Concepts of GIS –** Definition, GIS architecture, components, Operations, Objectives, Data exploration, Thematic layering, Topology **GIS Data Modals –**spatial, vector, raster, image, attribute data models, digital elevation model	**5**
5.	**Data Acquisition –** Digitizers, data processing, functions of GIS, spatial data relationships **Maps and map projections –** Types, scale, characteristics Coordinate system, Application of GIS	**6**
6.	**ARC GIS –** Introduction, mapping the real world with vector and raster data, Mapping Locations with Coordinate Systems, flattening the earth with map projections, application of ARC GIS	**7**

TOTAL	42

Suggested Textbook(s):

1. Gopi S., Sathikumar R. and Madhu N., “Advance Surveying”, third edition, 2010, Pearson.
2. Burrough, P.A., and McDonnell, R.A.,’Principles of Geographical Information Systems’, 2nd Edition, Oxford University Press, 1998.
3. Demers, M. N., Fundamentals of Geographic Information Systems, John Wiley & Sons, 3rd Edition, 2002.

Suggested Reference Book(s):

1. 'Remote Sensing and Image Interpretation', T.M. Lillesand and R.W. Kiefer, John Wiley & Sons, Singapore, 2002.
2. 'Introduction to Remote Sensing', J.B. Cambell, Taylor & Francis, UK, 2002.

3. 'Remote Sensing - Principles and Interpretation', F.F. Sabins Jr, W.H. Freeman & Co., New York, 1986.
4. 'Remote Sensing - Models and Methods for Image Processing', R.A. Schowengerdt, Elsevier India Pvt. Ltd., New Delhi, 2006.

Other useful resource(s):

Link to NPTEL courses:

1. https://nptel.ac.in/courses/105/103/105103176/
2. https://nptel.ac.in/courses/105/104/105104100/
3. https://nptel.ac.in/courses/105/101/105101206/
4. https://nptel.ac.in/courses/121/107/121107009/
5. https://nptel.ac.in/courses/105/103/105103193/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1.	T-1	15	1 Hour.	Syllabus covered upto T-1
2.	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Throughout the Semester	Assignment (4) – 10 Quizzes (2)-10 (Best Score) Attendance - 5

Course Outcomes (COs) contribution to the Program Outcomes (POs)

Course Outcomes	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	1	1	2	2	3	1	1	1	2	2	1	2	1.583
CO-2	2	2	2	2	3	2	1	1	2	1	1	2	1.75
CO-3	2	3	3	3	3	2	1	1	2	2	1	2	2.083
Average	1.667	2	2.333	2.333	3	1.667	1	1	2	1.667	1	2	

Introduction to Sustainable Engineering and Energy Efficient Buildings

COURSE CODE:

CREDITS: 3

CORE/ELECTIVE: OPEN

ELECTIVEL-T-P: 3-0-0

Pre-requisites: None

Course Objectives:

1. Understanding the concept of Sustainability
2. Introduction to various kinds of Pollutions and Global Environmental issues.
3. Understanding fundamentals Life Cycle Analysis.
4. Understanding the concept of EIA in India EMS and ISO 14001.
5. Introducing green Rating Systems and Energy Efficient Buildings.

Course Outcome

S. No.	Course Outcomes	Level of Attainment
CO-1	Introduction to the concept of Sustainability	Familiarity
CO-2	Introduction to various kinds of Pollutions and Global Environmental issues.	Familiarity
CO-3	Understanding fundamentals Life Cycle Analysis	Usage and Assessment
CO-4	Understanding the concept of EIA in India EMS and ISO 14001.	Familiarity
CO-5	Introducing green Rating Systems and Energy Efficient Buildings.	Usage and Assessment

Course Content

Unit	Concept	Lectures
1	**Understanding the concept of Sustainability** Introduction of the concept of Sustainability; Sustainable Development; Nexus between Technology and sustainable development; challenges to sustainable development; multilateral environmental agreements and protocols; clean development mechanism; Environmental legislations in India;	6

	Various measures adopted to promote sustainability; Carbon Credits and Carbon trading footprints.	
2	**Understanding about Pollution and Various Environmental Issues** Air Pollution; Effects of Air pollution; Water Pollution; Solid waste Management; Concept of Zero Waste; 3R concept; Global Environmental Issues; Global Warming; Ozone Depletion; Regional and Local Environmental Issues.	**7**
3	**Overview of LCA; EIA and EMS.** Environmental Management Standards; ISO 14000 series; Life Cycle Analysis; Environmental Impact Assessment; Procedures for EIA in India	**7**
4	**Understanding of Sustainable Materials** Concept of Sustainable Materials; Material Selection for sustainable design; Components of embodied energy, calculation of embodied energy for materials.	**5**
5	**Energy Efficient Systems and green building systems** Green buildings rating Systems Heating and ventilation design-Human thermal comfort, climatological factors, material specifications and heat transfer principles, Thermal performance evaluation, Heat loss from buildings, design of artificial ventilation system, design of insulators. Design audits & economic optimization-Concept of cost/benefit of energy conservation & carbon footprint estimation. Energy efficient lighting system design: Basic terminologies and standards, day lighting and artificial lighting design. Life Cycle energy use. Control of energy use in building, of LEED and TERI GRIHA ratings. Role of insulation and thermal properties of construction materials, influence of moisture content and modeling. Performance ratings of green buildings. Zero energy building.	**17**
Total lectures		**42**

NPTEL

https://nptel.ac.in/courses/105/102/105102175/
https://nptel.ac.in/courses/105/102/105102175/
https://nptel.ac.in/courses/105/105/105105157/
https://nptel.ac.in/courses/127/105/127105018/

Textbooks

1. National Building code
2. Energy Efficiency and Management Mehmet Kanoglu; Yunus A Cengel
3. Larry W Canter: Environmental Impact Assessment, Mc Graw Hill Publishers.
4. Introduction To Sustainability Environmental Social And Personal Perspectives 2Nd Edition by Martin Mulligan, Taylor & Francis

Evaluation Scheme

S. No.	Exam	Marks	Duration	Coverage/Scope of Examination
1.	T-1	15	1 Hour.	Syllabus covered upto T-1
2.	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Quiz (Best of 3) – 15 Marks Quiz (1) 5 Attendance - 5

Course Outcomes (COs) contribution to the Program Outcomes (POs)

Course Outcomes	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	1	2	2	2	3	3	3	1	2	3	3	**2**
CO-2	2	2	2	2	2	3	3	2	2	2	3	3	**2**
CO-3	3	2	2	2	2	3	3	3	2	1	2	3	**2**
CO-4	2	2	2	2	2	2	3	3	2	2	3	3	**2**
CO-5	2	1	2	2	2	2	3	2	2	2	2	3	**2**
Average	**2**	**1**	**2**	**2**	**2**	**2**	**3**	**2**	**1**	**2**	**2**	**3**	

Digital Image Processing using Python

COURSE CODE:
COURSE CREDITS:
CORE/ELECTIVE: ELECTIVE
L-T-P:

Pre-requisite: None

Course Objectives:

1. To introduce various fundamentals of Digital Image Processing.
2. To provide hands-on practice on different image processing methods using python.

Course Outcomes:

Sl. No.	Course Outcomes	Level of Attainment
CO-1	Able to understand the process of image acquisition.	Familiarity
CO-2	Able to implement different image processing methods for enhancement, edge detection and segmentation.	Assessment
CO-3	Able to implement different image processing methods on python	Usage
CO-4	Understand the concept of machine learning in images.	Familiarity

Course Contents:

Unit	Contents	Lectures required
1	**Introduction to Image Processing:**- Acquisition of Images, Image Sampling and quantization, Intensity and Spatial Resolution of Images.	**7**
2	**Introduction to Python and OpenCV:** Introduction to Numpy, Pandas, and OpenCV. Implementation of basic functions like reading & writing an image, cropping, resizing, rotation of images.	**7**
3	**Image enhancement:** Histogram and contrast on an image, point processing of an image, processing in spatial domain, processing in spectral domain, noise modeling. Implementation of enhancement methods using python.	8
4	**Edge Detection:** Point detection, line detection, different gradient operators, Laplacian operator, and Canny edge detection. Implementation of edge detection using python.	8
5	**Image Segmentation:** Intensity thresholding based image segmentation; Region growing and region splitting algorithm; watershed segmentation. Implementation of segmentation methods using python.	**7**

6	**Machine Learning based Image Processing:** Introduction to Machine Learning and convolutional neural network.	**5**
Total lectures		**42**

Suggested Text Book(s):

1. RC Gonzalez, RE Woods, Digital Image Processing, 3rd Ed., Pearson Publisher, 2008.
2. Ravishankar chityala, Sridevi Pudipeddi, Image Processing and Acquisition using Python, 2nd Ed., CRC Press, 2020.

Suggested Reference Book(s):

1. Chris Solomon, Toby Breckon: Fundamental of Digital Image Processing, 1st Ed., John Wiley & Sons, 2011.
2. Jan Erik Solem, Programming Computer Vision with Python: Tools and Algorithms for Analyzing Images, O'Reilly Media, 2012

Other useful resource(s):

1. https://nptel.ac.in/courses/108/103/108103174/ (Prof. M.K. Bhuyan, Electrical Engineering, IIT Guwahati)
2. https://docs.opencv.org/4.x/d9/df8/tutorial_root.html

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered up to T-1
2	T-2	25	1.5 Hours	Syllabus covered up to T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Avg.
CO1	3	3	2	2	2	2	3	1	2	3	3	1	2.2
CO2	3	1	3	2	1	2	3	2	2	3	2	2	2.1
CO3	3	3	2	2	1	2	2	2	3	2	1	2	2.1
CO4	3	2	2	2	2	2	2	2	2	2	2	1	2.0
Avg.	3	2.2	2.2	2	1.5	2.0	2.5	1.7	2.2	2.5	2.0	1.5	

Renewable Energy Systems

COURSE CODE:
COURSE CREDITS: 3
CORE/ELECTIVE: Open Elective
L-T-P: 3-0-0

Pre-requisite:- None

Course Objectives:

1. To study the non conventional energy systems, resources and performance parameters
2. Technology included will be Solar, Wind, Hydro, Batteries and Fuel Cells etc.

Course Outcomes:

Sr. No.	Course Outcomes	Level of Attainment
CO-1	Quantities of Energy , Sources of Energy	Familiarity
CO-2	Solar energy, Solar Radiation, Solar Spectrum, Solar technologies	Familiarity
CO-3	Solar Photovoltaic Devices, Performance and Durability of Solar Devices.	Usage
CO-4	Wind Energy and Technological Aspects, Batteries and Fuel Cells.	Assessment

Course Contents:

Unit	Contents	Lectures
1	**Introduction:** Renewable Energy Technologies, Conventional Sources of Energy. Energy Consumption and Energy Sector. Environmental consequences of oil fuel use, Importance of renewable sources of energy, Sustainable Design and development, Types of RE sources, Limitations of RE sources, Present Indian and International energy scenario of conventional and RE sources.	8
2	**Solar Energy and Thermal Systems:** Solar Energy Incident on Earth ,Solar radiation measurement Solar Spectrum, Solar Budget, Solar Plate Reflector, Solar Radiator, Basics of Semiconductor, PN –Junction Diode, Solar Cell Constructions, characteristic and Usage. Solar Photovoltaic systems: Basic Principle of SPV conversion – Types of PV Systems- Types of Solar Cells. Photovoltaic cell concepts: Cell, module, PV Module I-V Characteristics, Efficiency & Quality of the Cell, series and parallel connections, maximum power point tracking.	10
3	**Wind Energy**: Basics and concepts, Efficiency, Parts and design. Characteristics and power generation from Wind Energy.	8
4	**Batteries**: Battery basics, testing and performance Li-ion Batteries, Common Battery Structures and types.	9
5	**Fuel Cell**: Types of Fuel Cell, Fuel Processing for PEM Fuel cells Fuel cell concept to product, Fuel Cell parts and assembly, characteristics and Durability. Supercapacitors.	7
Total lectures		42

Suggested Text Book(s):

1. Renewable Energy- Edited by Godfrey Boyle-oxford university, press, 3rd edition, 2013.
2. Handbook of renewable technology Ahmed and Zobaa, Ramesh C Bansal, World scientific, Singapore.
3. Solar Energy: Principles of Thermal Collection and Storage, S. P. Sukhatme and J. K. Nayak, TMH, New Delhi, 3rd Edition.
4. Renewable Energy Resources, John Twidell and Tony Weir, Taylor and Francis -second edition, 2013.
5. Non-Conventional Energy Sources /G.D. Rai, Khanna Publishers.

Suggested Reference Book(s):

1. Non conventional energy source –B.H. Khan- TMH-2nd edition.
2. Integrated energy systems modeling--Karlsson, Kenneth Bernard; Skytte, Klaus Morthorst;Publishedin:DTU International Energy Report 2015

Other Useful Online Resources:

1. https://nptel.ac.in/courses/121/106/121106014/
2. https://nptel.ac.in/courses/103/103/103103206/
3. https://nptel.ac.in/courses/108/108/108108078/

Evaluation Scheme

Sr. No	Exam	Marks	Duration	Coverage/ Scope of Examination.
1	T-1	15	1 Hour	Syllabus covered up to T-1
2	T-2	25	1.5 Hours	Syllabus covered up to T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) – 10 Quizzes (2) – 10 Attendance (5)

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Design and Analysis of Algorithms)	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**Average**
CO-1	3	3	3	3	3	1	1	3	3	3	1	3	**2.5**
CO-2	2	2	2	2	2	1	1	1	2	1	1	2	**1.6**
CO-3	3	3	3	3	3	1	1	1	3	1	1	3	**2.2**
CO-4	2	2	2	2	2	2	1	1	2	1	2	2	**1.8**
Average	**2.5**	**2.5**	**2.5**	**2.5**	**2.5**	**1.25**	**1**	**1.5**	**2.5**	**1.5**	**2.4**	**2.4**	

Biomedical Imaging Systems

COURSE CODE:
COURSE CREDITS: 3
CORE/ELECTIVE: OPEN ELECTIVE
L-T-P: 3-0-0

Pre-requisite: None
Course Objectives:

1. To keep the learners abreast with the technological developments in the field of Medical Imaging.
2. To familiarize the learners with the various Imaging modalities in medicine, their operating principles and quality control aspects.

Course Outcomes:

S.No.		Level of Attainment
CO-1	Communicate with the experts and discuss problems in this field.	Familiarity
CO-2	Explain and give examples of technology and physics, and clinical use of the four dominant imaging modalities.	Familiarity
CO-3	Describe the market, the costs and other economical aspects of medical imaging.	Assessment
CO-4	Explain the tomography technique and use computer tools to reconstruct cross-sectional images by using this technique.	Assessment
CO-5	Explain and give examples of how the communication of medical images in digital radiology departments works.	Usage

Course Contents:

Unit	Contents	Lectures required
1	**Introduction** : Signals Systems review, Image Quality metrics, Fourier Transforms Review of 1D transforms and systems, Spatial transforms, 2D transforms and systems, Sampling in 2D, Introduction of Medical imaging, various modalities.	5
2	**Medical imaging modalities** : planar x-ray, x-ray computed tomography (CT), DEXA, magnetic resonance imaging (MRI), nuclear medicine imaging - positron emission tomography (PET) & single-photon emission computed tomography (SPECT), ultrasound imaging, and spectral imaging.	10
3	**Image Processing** : Images, Histograms, Image Enhancements, Edge detection, Image Filtering, Morphological Operators, Image segmentation	7
4	**Image Transformation Techniques :** Need for transform, Fourier, Cosine transforms, Haar, KL Transform, Singular value decomposition, 2D Wavelet transform, Different properties of image transform techniques.	8
5	**Image Restoration and Denoising** Image degradation, Type of image blur, Classification of image restoration techniques, ,image restoration model, Linear and non linear restoration techniques, Image denoising, Median filtering	5
6	**Biomedical imaging systems and analysis** : Microscopy including how images are formed and what types of information they provide.	7
Total lectures		42

Suggested Text Book(s):

1. Introduction to Biomedical Imaging, by Andrew R Webb, Wiley-IEEE Press, November 2017
2. Medical Imaging Systems: An Introductory Guide, by Andreas Maier, Stefan Steidl, Vincent Christlein, Joachim HorneggerAug 2018, Springer
1. Foundations of Medical Imaging , Z. H. Cho, J. P. Jones, and M. Singh , Wiley , 1993
2. Medical Imaging, Signals and Systems, Prince & Links, Pearson Prentice Hall, 2005
3. An Introduction to the Principles of Medical Imaging, Guy & ffytche, Imperial College Press, 2005

Suggested Reference Book(s):

1. Biomedical Imaging Instrumentation: Applications in Tissue, Cellular and Molecular Diagnostics: 2 (Primers in Biomedical Imaging Devices and Systems) Paperback – Import, 1 December 2021 by Suar Mrutyunjay, Misra Namrata, Bhavesh Neel Sarovar
2. Deep Learning Models for Medical Imaging. Primers in Biomedical Imaging Devices and Systems, September 2021, Elsevier Science and Technology
3. https://nptel.ac.in/courses/102/105/102105090/
4. Medical Imaging Systems A Macovski (1983, Prentice-Hall) – on reserve in library.
5. Principles of Magnetic Resonance Imaging Dwight Nishimura (2016) – Available ($35) at http://www.lulu.com/spotlight/dgn59
6. Diagnostic Ultrasound Imaging: Inside Out Thomas Szabo (2014) Available as an ebook through UM Libraries at http://www.sciencedirect.com/science/book/9780123964878
7. Medical Imaging Equipment Theory, 2nd Ed Richard Aston (2008) (Free electronic copy on course website)
8. Introduction to Biomedical Imaging https://www.edx.org/course/introduction-to-biomedical-imaging
9. Fundamentals of Biomedical Imaging: Ultrasounds, X-ray, positron emission tomography (PET) and applications https://www.edx.org/course/fundamentals-of-biomedical-imaging-ultrasounds-x-r

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes(2) -10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Biomedical Imaging Systems)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	1.75
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	2
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	1.75
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	2.08
CO-5	2	3	3	3	2	1	1	1	2	3	2	2	2.08
Average	2	2.6	2.6	2.6	2.4	1	1	1	2	2.4	1.6	2	

Digital Twin -- Fundamental Concepts to Applications in Advanced Manufacturing

COURSE CODE: xxxxxxxxxx

COURSE CREDITS: 3

CORE/ELECTIVE: OPEN ELECTIVE

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

1. Learn about fundamental ideas about sensor electronics and data acquisition
2. Provide good understanding of how signal and image processing techniques can be used in digital replica of physical process.
3. To understand high-level overview of digital twins and their underutilization in the field of asset management and maintenance.
4. To implement artificial intelligence and machine learning for decision making.
5. To explore the necessity for the practical application of Digital Twin in Industry.
6. Deploys developed digital twins on Amazon Web Services.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Describe the role of digital twin in the modern era of manufacturing.	Familiarity
CO-2	Sensor dynamics conversion in Sensor electronics	Assessment
CO-3	Signal Processing and Image Processing for Digital Twin	Assessment
CO-4	Data Communication-Edge, Fog, and Cloud Computing	Assessment
CO-5	Artificial Intelligence and Machine Learning in Manufacturing	Usage
CO-6	Digital Twin Application in terms of prototypes	Usage

Course Contents:

Unit	Contents	Lectures required
1	**Evolution of Manufacturing and Its Journey Towards Digital Twin:** A Few Fascinating Facts, Manufacturing and the Industrial Revolution, Instruction set design, Introduction to Digital Twin, Key-Aspects of a Digital Twin Model, Components for Envisaging the Digital Twin, Utilities of the Digital Twin in Manufacturing	4
2	**Sensor Electronics for Digital Twin:** The Need for Electronics in Manufacturing, Introduction to Sensor and Transducer, Role of a Sensor in Manufacturing**,** Types of Sensors, A Guide on Sensors for Digital Twins, Performance Indices of a Sensor	4
3	**Signal Processing for Digital Twin:** Introduction to Signal , Meaning of the Term 'Signal', Signal as Indirect Means of Monitoring , Importance of Signal Processing in Digital Twin, Signal Acquisition and Its Features, Signal Conditioning, Analogue-to-Digital Converter, The Sampling Rate of a Signal, Signal Acquisition, Arduino Microcontroller, Input/Output Module and PLC for Industrial Applications, Noise in Signal, Methods of Signal Processing	6
4	**Image Processing for Digital Twin:** Selection of Process Zone or Application Zone, Image Acquisition, Image Enhancement, Image Segmentation, Feature Extraction and Object Recognition, Texture Analyses Summary of Various Image Processing Techniques Used for Real-Time Process Control and Inspection in Manufacturing	6
5	**Data Communication-Edge, Fog, and Cloud Computing**: loT and Network, IoT Framework, Introduction to the Edge. Fog, and Cloud Computing, The Necessity of Cloud and Edge Computing in Industry 4.0 Perspective, Edge Versus Cloud Computing, Application Classification, Data Communication Technologies, Network Architectures for Edge/cloud Computing, Real-Life Example in Manufacturing Futuristic Concept-5G in Manufacturing	10
6	**Artificial Intelligence and Machine Learning in Manufacturing:** Introduction to Artificial Intelligence, Foundation of Artificial Intelligence, Requirement of Artificial Intelligence in a Digital Twin, Deep into Artificial intelligence—The Knowledge Pyramid, Sensor Signal Processing, , Machine Learning, Artificial Neural Network, Adaptive Filtering, Deep Learning, Transfer Learning, Automation of Sensor Data Fusion and Sensor Selection, Automation of Compression and Partitioning.	6
7	**Digital Twin Application:** Concept of Digital Twin, Realizing a Digital Twin, Model Digital Twin as a Tool Throughout the Life Cycle, Digital Twins for Design and Manufacturing, Digital Twin for Iron and Steel Product Life Cycle, Digital Twin for Weld-Joint Life Cycle, Digital Thins for Service, Challenges and Intelligence, Real-Life Examples in Manufacturing	6
Total lectures		**42**

Suggested Text Book(s):

1. Pal, Surjya Kanta, Debasish Mishra, Arpan Pal, Samik Dutta, Debashish Chakravarty, and Srikanta Pal. "Digital Twin–Fundamental Concepts to Applications in Advanced Manufacturing." (2021).
2. Khaled, Nassim, Bibin Pattel, and Affan Siddiqui. Digital Twin Development and Deployment on the Cloud: Developing Cloud-Friendly Dynamic Models Using Simulink®/SimscapeTM and Amazon AWS. Academic Press, 2020.

Other useful resource(s):

[1] https://www.elsevier.com/books/practical-design-and-application-of-model-predictivecontrol/khaled/978-0-12-813918-9.
[2] https://www.springer.com/gp/book/9781447123293.
[3] https://www.mathworks.com/discovery/digital-twin.html.
[4] https://aws.amazon.com/marketplace/pp/Bosch-Software-Innovations-Bosch-IoT-Things/B07DTJK8MV.
[5] https://www.comsol.com/.
[6] https://www.simscale.com/.
[7] https://www.anylogic.com/.
[8] https://www.mathworks.com/.
[9] https://www.ansys.com/
[10] https://www.mathworks.com/company/aboutus.html.

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Digital Twin -- Fundamental Concepts to Applications in Advanced Manufacturing	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	3	3	3	2	3	3	2	2	1	1	
CO-2	3	3	3	3	3	2	3	3	2	2	1	1	
CO-3	3	3	3	3	2	3	2	2	2	2	1	1	
CO-4	3	3	3	2	3	2	2	2	2	2	1	1	
CO-5	3	3	2	2	2	2	2	2	2	1	1	1	
Average	2	2	2	2	2	2	2	2	2	1	1	1	

Affective Computing

COURSE CODE: ……

COURSE CREDITS: 3

CORE/ELECTIVE: OPEN ELECTIVE

L-T-P: 3-0-0

Pre-requisite: None

Affective computing is the study of how emotions can have a major impact within intelligent interactive computer systems. Emotions are known to be central and basic to human interaction. Affective computing researchers attempt to bring emotions into artificial systems that interact with humans. Research in this area focuses on some primary areas. The study of basic theories of emotion, from psychological, sociological, and neuroscientific perspectives. Then, the study of techniques to recognize emotion from physiological signals including speech, heart rate, skin conductance, eye gaze and body posture. Also the study of how to generate believable emotional signals in virtual agents, including embodied conversational agents, avatars, assistive agents, and chat bots. Finally, the study of how to implement theories of emotion in particular domains, to make them useful intelligent interactive systems.

Course Outcomes:

S No	Course Outcomes	Level of Attainment
CO-1	To recognize, express, model, communicate, and respond to emotional information, instances of ''affective computing.''	Familiarity
CO-2	To communicate the human emotion via face, voice, physiology, and behavior; construction of computers, agents, and robots having skills of emotional intelligence	Assessment
CO-3	To perform emotion in decision-making and learning; and affective technologies for education, autism, health, and market research applications	Assessment
CO-4	To study the various applications of "affective computing"	Familiarity

Course Contents:

Unit	Contents	Lectures required

1	**Theories and Models** • Short History of Psychological Perspectives on Emotion • Neuro scientific Perspectives of Emotion • Appraisal Models • Emotions in Interpersonal Life: Computer Mediation, Modeling, and Simulation • Social Signal Processing • Affect and Machines in the Media	**6**
2	**Affect Detection** • Automated Face Analysis for Affective Computing • Automatic Recognition of Affective Body Expressions • Speech in Affective Computing • Affect Detection in Texts • Physiological Sensing of Emotion • Affective Brain-Computer Interfaces: Neuro scientific Approaches to Affect Detection • Interaction-Based Affect Detection in Educational Software • Multimodal Affect Recognition for Naturalistic Human-Computer and Human-Robot Interactions	**12**
3	**Affect Generation** • Facial Expressions of Emotions for Virtual Characters • Expressing Emotion Through Posture and Gesture • Emotional Speech Synthesis • Emotion Modeling for Social Robots • Preparing Emotional Agents for Intercultural Communication	**10**
4	**Methodologies and Databases** • Multimodal Affect Databases: Collection, Challenges, and Chances • Ethical Issues in Affective Computing • Research and Development Tools in Affective Computing • Emotion Data Collection and Its Implications for Affective Computing • Affect Elicitation for Affective Computing • Crowd Sourcing Techniques for Affective Computing • Emotion Markup Language • Machine Learning for Affective Computing: Challenges and Opportunities	**6**

5	**Applications of Affective Computing** • Feeling, Thinking, and Computing with Affect-Aware Learning Technologies • Enhancing Informal Learning Experiences with Affect-Aware Technologies • Affect-Aware Reflective Writing Studios • Emotion in Games • Autonomous Closed-Loop Biofeedback: An Introduction and a Melodious Application • Affect in Human-Robot Interaction • Virtual Reality and Collaboration • Unobtrusive Deception Detection • Affective Computing, Emotional Development, and Autism • Relational Agents in Health Applications: Leveraging Affective Computing to Promote Healing and Wellness	**8**
	Total lectures	**42**

Suggested Text Book(s):

1. Affective Computing By Rosalind W. Picard , The MIT Press https://mitpress.mit.edu/books/affective-computing
2. Analyzing Social Networks 1st Edition by Stephen P Borgatti, Martin G. Everett, Jeffrey C. Johnson, SAGE Publications Ltd; 1 edition
3. The Oxford Handbook of Affective Computing Edited by: Rafael Calvo ,Sidney D'Mello , Jonathan Gratch , and Arvid Kappas

Suggested Reference Book(s):

1. Influence and Behavior Analysis in Social Networks and Social MediabyMehmet Kaya, Reda Alhajj, Lecture Notes in Social Networks, Springer International Publishing
2. Emerging Research Challenges and Opportunities in Computational Social Network Analysis and Mining by Nitin Agarwal, NimaDokoohaki, Serpil Tokdemir, Lecture Notes in Social Networks, Springer International Publishing
3. Affective Computing and Interaction: Psychological, Cognitive and Neuroscientific Perspectives.www.igi-global.com https://www.igi-global.com › book › affective-computing

Other useful resource(s):

- https://onlinecourses.nptel.ac.in/noc21_ge21/preview
- https://cs.uwaterloo.ca/~jhoey/teaching/cs886-affect/schedule.html

- https://ocw.mit.edu/courses/media-arts-and-sciences/mas-630-affective-computing-fall-2015/lecture-notes/

Related Journals and Conferences

- IEEE Transactions on Affective Computing
- IEEE Transactions on Pattern Analysis and Machine Intelligence
- Proceedings of the ACM on Interactive, Mobile, Wearable and Ubiquitous Technologies
- Association for the Advancement of Artificial Intelligence
- International Conference on Affective Computing & Intelligent Interaction
- ACM CHI Conference on Human Factors in Computing Systems

Evaluation Scheme:

S No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes(2) -10 Attendance - 5

Course Outcomes (COs) contribution to the Programm eOutcomes(POs)

Affective Computing	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**Average**
CO-1	3	2	2	2	2	3	2	2	2	2	2	2	**2.2**
CO-2	3	3	3	2	2	3	3	2	2	2	1	1	**2.3**
CO-3	3	3	3	2	2	2	3	2	2	2	3	2	**2.4**
CO-4	3	3	2	2	2	2	2	2	3	2	2	3	**2.3**
Average	**3**	**2.8**	**2.5**	**2**	**2**	**2.5**	**2.5**	**2**	**2.3**	**2**	**2**	**2**	

Department of Biotechnology & Bioinformatics

Intellectual Property Rights and Commercialization

COURSE CODE: 18B1WBT732

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

1. To provide an insight and understanding about different aspects of protection of inventions and research developments
2. Learn about procedures for filling protection through Intellectual Property Rights.
3. To provide scopes of protection of diverse intellectual properties and its commercialization for socio-economic improvement.

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Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	To enable students with basic concepts and knowledge of intellectual property rights.	Awarness
CO-2	To apply and execute different types of IP protection in research and academics.	Assessment and technical skills
CO-3	Able to understand about the mechanisms of different IP protections, registrations and applications	Technical
CO-4	To be capable of tackling issues related to IP and its commercialization	Assessment
CO-5	Able to learn the strategies for effective IP management and commercialization	Analytical skills
CO-6	To apply the knowledge of IPR for the benefit generation and for mass utilization	Usage

Course Contents:

Unit	Contents	Lectures required

1	**Introduction**:Introduction of Intellectual properties and rights conferred . Integration of Intellectual Property, Bioethics and Biosafety for biological and applied sciences in research and academia.	4
2	**Types of IP tools**:Different types of IPR(Patents, copyrights and related rights, Trademark, Tradesecret, Integrated circuit layout, Geographical indications, Traditional knowledge, Industrial designs and PBR) Drafting Patent Application and Documentation Revocation of Patent, Litigation and Infringement Rationale of different IPR ,their mechanism of protection and provisions in Law	10
3	**International Agreements** and Treaties:International IP treaties (Madrid Agreement, Trademark law treaty, Patent Law treaty etc.) WIPO, EPC, WTO, and TRIPS. International agreements relevant to biotechnology-associated IP	8
4	**Commercialization**: Methods of commercialization,Impact of commercialization. Financing	6
5	**IP Management for value addition:** Strategies for IP Management and commercialization. IP audit, IP insurance Bioentreprenuership management	4
6	**Licensing/Assignment** :Types of licensing and modes to carry out, Assignments and its benefits, Compulsory Licensing Commercialization for social and economic prosperity with case studies	8
Total lectures		**42**

Suggested Text Book(s):

1. Intellectual Property Rights & Copyright By Bouchoux.
2. Intellectual Property Licensing Strategies by Thompson Reuters

Suggested Reference Book(s):

1. Intellectual Property Rights, the WTO and Developing Countries: The TRIPS ...Book by Carlos María Correa

2. Perspectives on Commercializing Innovation by F. Scott Kieff (Editor), Troy A. Paredes (Editor

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Intellectual Property Rights & Commercialization)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	1	1	2	2	**15**
CO-2	2	2	1	2	2	2	1	1	1	1	1	2	**1.5**
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	**1.7**
CO-4	2	2	3	3	2	1	1	1	2	2	2	2	**1.9**
CO-5	2	2	2	2	2	1	2	1	1	2	1	2	**1.6**
CO-6	2	2	2	2	2	2	1	1	2	2	2	2	**1.8**
Average	**3.4**	**3.4**	**2**	**2.1**	**2.1**	**1.3**	**1.1**	**1**	**1.5**	**1.6**	**1.5**	**2**	

Diagnostics & Vaccine Manufacturing

COURSE CODE:18B1WBT833

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Immunology

Course Objectives:

1. To familiarize the students with the principles & applications of the latest state-of-the-art bio-molecular diagnostic techniques/technology used in laboratories the world over.
2. The safety aspects, quality control, quality assurance and validation of PCR based diagnostics and laboratory safety.

3. Knowledge of various technologies employed in vaccine production and examine their use in developing vaccines against human and animal pathogens. The safety aspects, quality control, quality assurance and validation of vaccine production and will also be covered.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	The students would be able to identify and analyze what DNA based approach and methodology should be used for diagnostic purpose in different settings, their comparative advantages and limitations.	Usage
CO-2	The students would be able to identify and analyze what antigen - antibody based approach and methodology should be used for diagnostic purpose in different settings, their comparative advantages and limitations.	Usage
CO-3	The students would have in-depth knowledge of various types of vaccines and approaches used for their production.	Familiarity
CO-4	The students would have in-depth knowledge of quality control and assurance considerations used in the industry for diagnostics.	Assessment & Technical
CO-5	The students would have in-depth knowledge of antimicrobial susceptibility and its application in the industry for diagnostics.	Assessment & Technical

Course Contents:

Unit	Contents	Lectures required
1	**General Introduction**: Biotechnology in the diagnosis of infectious diseases and vaccine development, Biotechnology in Vaccine production, Recent developments in vaccine technology.	2
2	**Immunodiagnostics:** Antigen – Antibody Interaction, Lattice Theory, Precipitin Curve, Simple Immunodiffusion (Radial Immunodiffusion – Qualitative, Quantitative); Double Diffusion (Mechanism of Reaction of Identity, Partial – Identity, and Non-Identity); Immunoelectrophoresis; Rocket Electrophoresis, Western Blot, Immunofluorescence, Agglutination – Antibody titer, Prozone Phenomenon, Direct and Indirect Agglutination, Hemagglutination,	10

	ABO Blood typing, Agglutination Inhibition; Immunofluorescence, Radioimmunossay (including advantages and disadvantages).	
3	**ELISA:** Theory, Designing an ELISA method, Types – Direct, Indirect, Sandwich, Competitive, Dot ELISA.	**2**
4	**PCR:** concept, protocol, strategy. Types of PCR – Strategy and Applications - Nested, Semi-nested, Real time, RT-PCR, Asymmetric PCR, Inverse PCR, Multiplex PCR.	**3**
5	**QC & QA of PCR and Real Time based diagnostics**: Theory, Application, and Trouble shooting. Importance of controls. Best Fit Assay, Optimization and Standardization of PCR based diagnostics.	**3**
6	**AST**: Concept, KB Method. Laboratory methodologies for bacterial antimicrobial susceptibility testing – concepts, antibiotics –, resistance, mechanism. Disk diffusion, tube dilution, microbroth dilution methods.	**4**
7	Biosafety and biosecurity in the medical microbiology laboratory and animal facilities.	**2**
8	Different types of vaccines, i.e., sub-unit vaccines, recombinant vaccines, synthetic vaccines, idiotypic based - vaccines, DNA vaccines, glycoconjugate vaccines, deletion vaccines.	**3**
9	Examples of different vaccines - Rabies vaccines, PPRV vaccines, Chimeric vaccines – JEV/DENV/Westnile, Meningococcal conjugate & protein based vaccines, Oral B subunit + whole cell cholera vaccine, Multicellular Parasite vaccines, Novel Vaccines against *Mycobacterium tuberculosis,* Mycoplasma vaccines, Protozoal &rickettsial vaccines.	**8**

10	Genetic basis of attenuation, vaccine vectors, large-scale production of vaccines and automation. . Vaccine delivery system and approaches to enhance immunogenicity - immunomodulators and, immunomodulation adjuvant. Delivery of particulate antigens through liposomes, microspheres etc.	**5**
Total lectures		**42**

Suggested Text Book(s):

1. Burtis, C. A., Ashwood, E. R.,:Tietz textbook of Clinical Chemistry &Bruns, D. E. Molecular Diagnostics, Saunders, 2006
2. World Organization for: Manual of Diagnostic Tests and Vaccines for Animal Health Terrestrial Animals, Volumes I & II, 6th Edition, 2010.
3. Rao, J. R.:Molecular Diagnostics: current technology and Applications, Horizon Bioscience, U. K., 2006.
4. Review and Research Publications available on-line
5. Immunology: Kuby

Course Outcomes (COs) contribution to the ProgrammeOutcomes(POs)

Course outcomes (Diagnostics & Vaccine Manufacturing)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	1	1	1	1	1	1	1	0	0	0	2	1
CO-2	1	2	3	1	1	1	1	0	0	2	2	2	1.33
CO-3	1	2	2	2	1	2	1	1	1	2	2	1	1.5
CO-4	2	2	2	3	1	1	3	1	1	1	1	3	1.75
CO-5	1	2	3	2	2	2	1	2	2	2	2	3	2
Average	1.6	1.8	2.2	1.8	1.2	1.4	1.4	1	0.8	1.4	1.4	2.2	

Industrial Enzymes Technologies

COURSE CODE:18B1WBT731

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Enzyme production purification and applications

Course Objectives:

1. The objective of the course is to develop an understanding of important aspects of production and purification of industrially important enzyme and their application in industry.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	To develop an understanding of basic concepts of enzymes.	Familiarity
CO-2	To understand the basic mechanism of action and working behaviour of enzymes	Assessment
CO-3	To familiarize the students with various applications of enzymes in laboratory as well as Industrial scale.	Assessment
CO-4	To conceptualize about immobilized enzyme technology, and other specific enzymes and their applications.	Usage
CO-5	To familiarize the students with present potential of enzyme in industrial application and improved activity of the enzyme using various molecular biology techniques.	Usage
CO-6	To understand the principle and function of enzyme in various adverse conditions like high temperature and pH(s).	Assessment

Course Contents:

Unit	Contents	Lectures required
1	**Enzymes: Basic concepts:**Enzymes as powerful and highly specific catalysts, Classification of enzymes, free energy and enzymes, the formation of the transition state, catalytic strategies. General properties: Enzyme specificity, stability and structure, Factors affecting enzyme activity; effect of pH and Temperature, Substrate and Enzyme concentration.	**5**

2	**Enzyme kinetics**: Michaelis-Menten kinetics, evaluation of parameters in the Michaelis-Menten equation, 3-D structure of active site, Kinetics of single and bi-substrate enzyme catalysed reactions, Inhibition & its kinetics.	**5**
3	**Enzyme preparation techniques:** Sources of enzymes, production,Recovery and purification of intracellular products: cell disruption, chromatographic techniques. Analytical assays of purity level of enzymes.	**3**
4	**Enzyme preparation and application in industries:** Application of enzymes in leather, glucose syrup production, starch and sugar industry, Dairy and food industry, Beverage industry, Textile industry. Hydrolysis of starch and cellulose. Catalytic functions of Cellulase, lipase, esterase laccase amylase, glucose isomerase, protease, xylanase, invertase, peroxidises. Other applications of enzymes in solution: medical applications of enzymes, non-hydrolytic enzymes in current and developing industrial technology.	**10**
5	**Enzyme engineering:** Mechanisms and manifestations of protein denaturation. Strategies for enzyme stabilization: Physical and chemical modifications, Selection, directed evolution and Rational design. design and construction of mutant enzymes, Bifunctional and polyfunctional enzyme, Enzyme in organic solvents.	**5**
6	**Immobilized-enzyme technology**: Introduction, enzyme immobilization method: Entrapment, carrier-binding and cross-linking method. Medical and analytical applications of immobilized enzymes.	**8**
7	**Specified Enzymes and applications:** Thermozymes, Cold adapted enzymes, Ribozymes, Hybrid enzymes, Diagnostic enzymes, Therapeutic enzymes: Characteristics, principles and applications.	6
Total Lectures		**42**

Suggested Text Book(s):

1. Devasena, T., "Enzymology", 1st ed., Oxford University Press, 2010
2. Berg, J.M., Tymoczko, J.L. and Stryer, L., "Biochemistry", 5th ed., W.H. Freeman and Company, New York, 2002.
3. Nelson D.L., Cox M.M., "Lehninger Principles of Biochemistry", 5th ed., W.H. Freeman and Company, New York, 2008.

Suggested Reference Book(s):

1. Pye, E.K. and Wingard, L.B., "Enzyme Engineering II", Plenum Press, 1974.
2. Illanes A, "Enzyme Biocatalysis", Springer Science, 2008.

Other useful resource(s):

https://nptel.ac.in/course.php?disciplineId=102

Course Outcomes (COs) contribution to the ProgrammeOutcomes(POs)

Course outcomes	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	3	1	1	2	2	3	2	2	1	2	1.9
CO-2	1	2	2	2	2	1	-	2	2	2	1	3	1.8
CO-3	2	2	2	2	2	2	1	1	2	-	2	2	1.8
CO-4	2	3	2	1	2	1	-	1	3	2	-	2	1.9
CO-5	1	3	1	3	2	2	1	2	1	2	1	3	1.8
CO-6	1	1	-	2	2	2	2	1	2	2	1	3	1.7
Average	1.5	2.1	1.6	1.8	1.8	1.6	1	1.6	2	2	1.2	2.5	

NGS Data Analysis and Applications

COURSE CODE: 18B1WBI834

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite:

Course Objectives:

1. To acquire basic knowledge of Next Generation Sequencing approaches in genomic research.
2. To understand computational and statistical principles for analysing genomic data.
3. To understand and formulate questions to investigate deep sequencing data.

Course Outcomes

S.No.	Course Outcomes	Level of Attainment

CO-1	The students will acquire knowledge of Next Generation Sequencing technologies used in genomics and genetics research.	Familiarity
CO-2	The students will learn about the various platforms used in NGS.	Assessment
CO-3	The students will learn about the tools and techniques used in NGS data analysis.	Usage
CO-4	The students willknowtheapplications and scopes of genomics research using the latest genome-wide data centric approaches.	Assessment

Course Contents:

Unit	Contents	Lectures required
1	**Overview of Sequencing Technologies**: Historical perspective of sequencing technologies. Overview of modern sequencing technologies. Sanger Sequencing. Next Generation sequencing platforms. Whole genome sequencing.	4
2	**Next Generation Sequencing Data analysis:** Data acquisition and base calling. Quality of sequencing data. Read mapping and genome assembly. Structural and functional annotation of genomes. Statistics and algorithms used in different steps in data analysis.	10
3	**Technologies for Transcriptomics and Regulatory Genomics:** Chip-seqAnlysis. Peak finding. Motif Discovery. RNA-seq Analysis. Differential gene expression analysis. Exome sequencing and analysis. Exome sequencing.	9
4	**Software and pipelines for NGS Data Analysis:** Chip-seq analysis Piplines. RNA-seq analysis pipelines. Software used for assembly and differential gene analysis. Basics of Genome Browsers. Annotation pipelines.	9
5	**Genome Sequencing and Applications in Genetics Studies**: Algorithms and application in studying regulation of gene expression. Emerging technologies of single cell gene expression analysis. Metagenomics. Variant detection. Time series analysis. Pathway Analysis.	10
Total lectures		**42**

Suggested Text Book(s):

1. Genomic Data Analysis by Megahed Mohammad, LAP Lambert Academic Publishing
2. Deep Sequencing Analysis by Noam Shomrom, Springer.

Course outcomes	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12
CO-1	2	2	1	2	2	2	2	1	2	2	2	2
CO-2	1	2	1	2	2	2	2	2	2	2	1	2
CO-3	2	3	3	3	3	2	3	2	2	1	2	2
CO-4	2	3	3	3	3	2	3	2	2	1	2	2

Computational Biology for Engineers

COURSE CODE: XXXXXX

COURSE CREDITS: 03

Open Elective

L-T-P: 3-0-0

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Understanding the importance of biological information and its application using computers	Familiarity
CO-2	Students will learn about various biological data resources and information retrieval systems used in Bioinformatics.	Usage
CO-3	Students will learn about various tools for Biological database searching	Assessment
CO-4	Students will learn how to analyze biological sequence to obtain deep knowledge of biological functions of genes and proteins	Assessment
CO-5	Students will understand how to perform protein structure visualization and its importance in computational drug design	Usage

Course Contents:

S. No.	Unit	Topics Covered	Contact Hrs.
1	UNIT I	**History, scope and importance of Computational Biology:** Important contributions, aims and tasks of Bioinformatics, applications of Bioinformatics,Challenges and opportunities, the central dogma of molecular biology	2
2	UNIT II	**Biological databases and information resources:** Importance of biological databases, primary and secondary databases, DNA and protein sequence databases, Retrieval methods for DNA sequence, protein sequence and protein structure information, structure databases, bibliographic databases, Literature databases,Common sequence file formats, PubMED, GenBank, NCBI, EMBL, DDBJ, ExPASY	8
3	UNIT III	**Biological sequence analysis:** Sequence analysis of biological data, Significance of sequence alignment, pairwise sequence alignment methods, Dynamics programming in sequence alignment, Use of scoring matrices and gap penalties in sequence alignments, multiple sequence alignment, Tools and application of sequence alignments	10

4	UNIT IV	**Biological Database Searching using heuristics:** Dynamic programming vs. heuristics, FASTA and BLAST programs.	4
5	UNIT V	**Structural analysis of biological molecules:** Protein structure, protein structure prediction strategies, Homology modeling, Threading/Fold recognition, *Ab initio*modelling, molecular visualization tools.	9
6	UNIT VI	**Computational approaches in drug discovery:** Chemical databases, Drug target identification, Structure-based drug design**,** Ligand-based drug design, Molecular docking, HTS (High-Throughput Screening) vs. virtual screening, Pharmacophoremodelling.	9
	Total Number of Lectures		**42**

Suggested Text Book(s):

1. Essential Bioinformatics: Jin Xiong
2. Bioinformatics: D.W. Mount
3. Introduction to Bioinformatics by Arthur Lesk
4. Bioinformatics: Databases, tools and Algorithms by OrpitaBosu and SimminderKaurThukral
5. Knowledge discovery in Bioinformatics: Xiaouha Hu, Yi Pan

EvaluationScheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment, Quizzes&Attendance

HUMAN DISEASE AND DIAGNOSTICS

COURSE CODEXXXXXX

COURSE CREDITS: 3

Open Elective

L-T-P: 3-0-0

Course Objectives

1. The objective of the course is to develop an understanding of Human disease and basic methods used in diagnosis

Course Outcomes

Sr. No.	Course outcomes	Level of Attainment
CO I	Basic understanding of the human pathogens	Familiarity
CO II	Compare and contrast of DNA and RNA as relate to testing reagent	Familiarity
CO III	Able to understand biomolecule based diagnostic procedures	Assessment
CO IV	Describe the laboratory techniques used to detect: microorganisms, DNA polymorphisms and Cancer	Usage
CO V	To develop a strong foundation and thorough understanding of important diseases and diagnostic procedures	Usage

Modules

S. No.	Contents	Contact Hrs.
1	**Introduction to clinical samples;** Philosophy and general approach to clinical specimens (BSL 1-4)), Sample collection (Blood, nasal swab or throat sample, urine, spinal fluid, synovial fluid, amniotic fluid) - method of collection, preservation, transport and processing of samples	**5**
2	**Pathogens and Diagnosis;** Bacterial infection e.g., Tuberculosis, Diarrhea Viral infection e.g., COVID 19, Dengue fever Fungal infections e.g., Candidiasis, Mucormycosis Protozoan diseases e.g., Amoebiosis	**12**
3	**Protein based diagnosis concept and therapeutic agent;** Concept of antigen and antibody. Antigen – Antibody Interaction, ABO Blood typing, ELISA (HIV), Vaccine	**5**
4	**Health biomarker-life style based disorders**; Hormone based diagnostic techniques and their examples (TSH) and Vitamins, Lipid Biomarker Biosensors – types, applications e.g., glucose level Application and importance telemedicine,	**5**
5	**Cancer and Biomarker**; EGFR, PD-L1 (metastatis cancer), BRCA1/2, Esterogen receptor, progesterone receptor, TP53, Pharmacogenomics (Warfarin, Herceptin), PSA biomarker (Prostate cancer)	**8**
6	**Forensic science & COVID testing**; DNA fingerprinting (VNTR) and polymorphism studies (SNP, etc), RT-PCR (RNA or DNA viruses) e.g., SARS-CoV-2- COVID19), C_T Value-pathological burden	**7**
	Total Number of Lectures	**42**

REFERENCE & TEXT BOOKS;

1. Burtis, Carl A., Ashwood, Edward R, Bruns, David E., "*Tietz textbook of Clinical Chemistry & Molecular Diagnostics*" USA: Saunders, 2006.
2. World Organization for Animal Health: "*Manual of Diagnostic Tests and Vaccines for Terrestrial Animals"* Volumes I & II, 6th Edition, 2010.
3. Rao, Juluri R., Fleming, Colin C., Moore, John E., "*Molecular Diagnostics: current technology and Applications"*, Horizon Bioscience, U. K., 2006.
4. Mahon, Connie R., Lehman, Donald C., Manuselis, George, "*Textbook of Diagnostic Microbiology*". USA: Saunders, 2007.
5. Goldsby, Richard A., Kuby, Janis, "*Immunology*", New York: WH Freeman and Company, 2003.

Evaluation Scheme:

Assessment	Max. marks	Duration	Course Covered
Test-1	15	1 hr.	Syllabus covered upto T-1
Test-2	25	1.5 hrs.	Syllabus covered upto T-2
Test-3	35	2 hrs.	Entire Syllabus
Teacher Assessment	25	Entire Semester	Based on Assignments, quizzes etc.

Department of Physics and Materials Science

Science and Technology of Materials

COURSE CODE: 18B1WPH531

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE (ECE)

L-T-P: 3-1-0

Pre-requisite: None

Course Objectives:

1. To enable the students to get better understanding about materials, properties and their applications in engineering
2. To familiarize students for making proper selection of materials for different applications..
3. To enable the students to use the knowledge about materials for their projects and ultimately apply the materials knowledge in their respective professional career.
4. At the conclusion of the course, the student should have a far greater capacity to read and understand technical articles such as those seen in the IEEE Transactions on Electron Devices, IEEE Transactions on Nanotechnology, Computer-aided design, Computational Materials Science *etc*.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	To learn the fundamentals and Science of Materials.	Familiarity
CO-2	To implement the concepts and theories for analyzing the behaviour of the materials.	Familiarity
CO-3	To execute the concepts and theories in solving the problems related to material properties and their applications.	Analytical & Computational skills
CO-4	To introduce innovations in areas like Display Technology and Engineering Materials Science, etc.	Innovative Skills
CO-5	To analyze various materials for scientific and technical applications	Technical skills

Course Contents:

Unit	Contents	Lectures required
1	Introduction to Dielectric materials, Capacitance, Polarization, Types of Polarization, Polarization mechanism & Dielectric Constant, Frequency Dependence of the Dielectric Constant, Ferroelectricity, Piezoelectricity Applications of Dielectric Materials.	**10**
2	Introduction to Optoelectronic materials, Applications of Optical Phenomena Luminescence, Materials of Importance—Light-Emitting Diode Materials, photoconductivity, Lasers, Optical Fibers in Communications	**6**
3	Introduction to Thermoelectric materials, Figure of merit, Heat Capacity, Conductivity (electronic and thermal), Applications in sensors, energy harvesting etc.	**6**
4	Introduction to Magnetic materials, Concept of magnetism, Classification, dia-, para-, ferro-, antiferro- and ferri-magnetic materials, Influence of Temperature on Magnetic Behavior; Domains and Hysteresis; Magnetic Anisotropy Applications in storage devices.	**8**
5	Introduction to Superconducting materials, Superconductivity Meissner effect, Critical field, type-I and type-II superconductors; Field penetration and London equation; High temperature Superconductors and their Applications.	**4**
6	Introduction to Composite materials-Polymers & Ceramics, Various types of Polymers and their applications, Structure, Types, Properties and Applications of Ceramics, Electrical Conduction in Ceramics and Polymers. Applications.	**8**
Total lectures		**42**

Suggested Text Book(s):

1. S. O. Pillai, Solid State Physics, New age international publishers, 7th edition (2016)
2. William D. Callister and David G. Rethwisch, Materials science and engineering: an introduction, John Wiley & Sons, 8th edition (2010).
3. M.A. Wahab, Solid State Physics:Structure and Properties of Materials, Narosa, 3rd edition, (2015).

Suggested Reference Book(s):

1. Charles Kittel, Introduction to Solid State Physics. John Wiley & Sons, 8th edition 2005.
2. S. Sharma and J. Sharma, Engineering Physics, Pearson India (2018).

Other useful resource(s):

1. http://www.advancedsciencenews.com/best-of-advanced-optical-materials/
2. https://onlinecourses.nptel.ac.in/noc19_ph04/preview

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes(2) -10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Materials Science)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3										3	3
CO-2	3											3	3
CO-3	1	1	1									1	1
CO-4	2	2	2	2								2	2
CO-5	3	3	3	3					3			3	3
Average Score	2.4	2.25	2	2.5					3			2.4	2.425

Appendix-I (b)

Applied Materials Science

COURSE CODE: 18B1WPH532

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE (CSE, IT)

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

1. To enable the students to get better understanding about materials, properties and their applications in engineering
2. To familiarize students for making proper selection of materials for different applications..
3. To enable the students to use the knowledge about materials for their projects and ultimately apply the materials knowledge in their respective professional career.
4. At the conclusion of the course, the student should have a far greater capacity to read and understand technical articles such as those seen in the IEEE Transactions on Electron Devices, IEEE Transactions on Nanotechnology, Computer-aided design, Computational Materials Science *etc*.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	To learn the fundamentals and Science of Materials.	Familiarity
CO-2	To implement the concepts and theories for analyzing the behaviour of the materials.	Familiarity
CO-3	To execute the concepts and theories in solving the problems related to material properties and their applications.	Analytical & Computational skills
CO-4	To introduce innovations in areas like Display Technology and Engineering Materials Science, etc.	Innovative Skills
CO-5	To analyze various materials for scientific and technical applications	Technical skills

Course Contents:

Unit	Contents	Lectures required
1	Dielectrics: Polarization mechanism & Dielectric Constant, Behavior of polarization under impulse and frequency switching, Dielectric loss, Spontaneous polarization, Piezoelectric effect; Applications of Dielectric Materials.	**12**
2	Polymers: Various types of Polymers and their applications; Mechanical behaviour of Polymers, synthesis of polymers. Conducting polymers	**4**
3	Ceramics: Structure, Types, Properties and Applications of Ceramics; Mechanical 8behaviour and Processing of Ceramics	**3**
4	Magnetism: Concept of magnetism, Classification, dia-, para-, ferro-, antiferro- and ferri-magnetic materials, Their properties and Applications; Hysteresis; Applications.	**9**
5	Superconductivity: Meissner effect, Critical field, type-I and type-II superconductors; Field penetration and London equation; High temperature Superconductors and their Applications.	**6**
6	Optical fibres: Light propagation in fibers and Graded Index fibers, Numerical Aperture and Attenuation, Single and Multimode.	**4**
7	New Engineering Materials: Metallic Glasses, Shape Memory Alloys, Memory Effect, Nano-materials- significance of 8anoscale, 0-Dimensional, 1-Dimensional, 2- Dimensional, 3- Dimensional nanostructures, Applications.	**4**
Total lectures		**42**

Suggested Text Book(s):

1. S. O. Pillai, Solid State Physics, New age international publishers, 7th edition (2016)
2. William D. Callister and David G. Rethwisch, Materials science and engineering: an introduction, John Wiley & Sons, 8th edition (2010).
3. M.A. Wahab, Solid State Physics:Structure and Properties of Materials, Narosa, 3rd edition, (2015).

Suggested Reference Book(s):

1. Charles Kittel, Introduction to Solid State Physics. John Wiley & Sons, 8th edition 2005.
2. S. Sharma and J. Sharma, Engineering Physics, Pearson India (2018).

Other useful resource(s):

1. http://www.advancedsciencenews.com/best-of-advanced-optical-materials/
2. https://onlinecourses.nptel.ac.in/noc19_ph04/preview

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes(2) -10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Materials Science)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3										3	3
CO-2	3											3	3
CO-3	1	1	1									1	1
CO-4	2	2	2	2								2	2
CO-5	3	3	3	3					3			3	3
Average Score	2.4	2.25	2	2.5					3			2.4	2.425

Department of Physics and Materials Science

Nanotechnology

COURSE CODE: 18B1WPH731
COURSE CREDITS: 3
CORE/ELECTIVE: Elective
L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

1. To provide basic knowledge of nanoscience & technology.
2. To make students familiar with synthesis techniques of nanomaterials
3. To make students familiar with characterization techniques and tools.
4. At the conclusion of the course, the student should have a far greater capacity to read and understand technical articles such as those seen in the IEEE Transactions on Electron Devices, IEEE Transactions on Nanotechnology, etc.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Students will be able to learn basics of nanotechnology.	Familiarity
CO-2	Synthesis of nanomaterials based on requirement.	Familiarity and Assessment
CO-3	Characterization techniques and tools.	Assessment
CO-4	Students will learn the effect of nano-transformation on properties of materials.	Familiarity, Assessment and Usage
CO-5	Applications of nanotechnology in their respective fields as well as in interdisciplinary science and engineering.	Assessment and Usage

Course Contents:

Unit	Content	Lectures required
1	Introduction to Nanotechnology: Surface energy. Nanoparticles etc.	**5**
2	Synthesis of nanomaterials: Different approaches of synthesis (chemical,	**9**

	mechanical, etc.)	
3	Characterization techniques: SEM, STM, AFM, X-ray diffraction, etc.	**10**
4	Properties of nanomaterials: Electronic, magnetic, optical, chemical and mechanical properties.	**12**
5	Applications of nanomaterials: Nanostructured materials in memory and electronic devices and for magnetic recording, sensors and interfaces, Biological applications.	**6**
Total Lectures		**42**

Suggested Text Book(s):

1. Michael Köhler, Wolfgang Fritzsche, Nanotechnology An Introduction to Nanostructuring Techniques, Wiley, 2nd edition, (2008).
2. G. Cao, Y. Wang, Nanostructures and Nanomaterials: Synthesis, Properties and Applications, World Scientific Series in Nanoscience and Nanotechnology, 2nd edition (2011).
3. Charles P. Poole, Jr., Frank J. Owens, Introduction to Nanotechnology, Wiley, (2003).

Suggested Reference Book(s):

1. Zheng Cui,Micro-Nanofabrication: Technologies and Applications , Springer; (2005).
2. Bhushan, Bharat (Ed.), Springer Handbook of Nanotechnology, Springer-Verlag Berlin Heidelberg (2017).
3. Guozhong Cao and Ying Wang, World Scientific Series in Nanoscience and Nanotechnology: Volume 2 , Nanostructures and Nanomaterials, Synthesis, Properties, and Applications, 2nd Edition (2011).

Other useful resource(s):

1. NPTEL course contents links
2. https://nanohub.org/groups/education
3. All relevant research articles

Evalution Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2

3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Couse Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Nanoscience and Technology)	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**Average**
CO-1	3	2	3	3	3	2	1	2	1	1	1	1	1.91
CO-2	3	3	2	2	3	1	2	2	1	1	1	1	1.83
CO-3	3	3	3	3	3	2	1	1	1	1	1	1	1.91
CO-4	3	2	3	2	2	1	1	1	1	1	1	1	1.58
CO-5	3	3	3	3	3	3	2	2	2	2	2	2	2.5
Average	3.00	2.60	2.80	2.60	2.80	1.80	1.40	1.60	1.20	1.20	1.20	1.20	

Appendix-II (b)

Optical Fiber Network Design

COURSE CODE: 18B1WPH732

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

1. Learn to analyze algorithms for Time and Space Complexity
2. Learn asymptotic notations for performance analysis of algorithms.
3. Learn various computing algorithms and data structure used in solving complex problems.
4. Apply important algorithmic design paradigms and method of analysis.
5. Synthesize efficient algorithm design in common engineering design situations.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	To revise and understand about the basic working of optical fibers	Familiarity
CO-2	To design the basic structure of optical fibers	Assessment
CO-3	To understand the layout of optical fiber networks.	Assessment
CO-4	Apply CO-02 and 03 to design and understand working of optical fiber networks.	Usage

Course Contents:

Unit	Contents	Lectures required
1	**Basics of fiber optics:** Propagation, Dispersion, Attenuation and loss limits, Wave propagation in step index fibers, fiber gratings, Nonlinear effects in Fibre	**10**
2	**Optical fiber components** Optical fiber splices, connectors, couplers, Transmitters and Receivers	**5**
3	**Optical Link design:** Data Coding, Source selection, Power Budget, Optical amplifiers, dispersion compensation, Solitons, Soliton link Design	**10**

4	**Single wavelength fiber optic networks:** Network topologies, Standard fiber networks, FDDI networks, SONET/SDH	**10**
5	**Wavelength division multiplexing:** Selective WDM, Broad band WDM, Multiplexers, sources, nonlinearity in WDM links, WDM and optical amplifiers, Multipoint, Multi wavelength networks	**7**
Total lectures		**42**

Suggested Text Book(s):

1. Gerd Keiser: Optical Fiber Communication, 4th Edition, Tata McGraw-Hill Ltd., 2008.
2. A. Ghatak, K. Thyagarajan: Introduction To Fiber Optics, Foundation Books, 2002.
3. J. M. Senior: Optical Fiber Communications Principles and Practice, 2nd Edition, Prentice Hall India Pvt. Ltd., 2004.

Suggested Reference Book(s):

1. Govind P Agrawal: Fiber-Optic Communication Systems, John Wiley & Sons Asia, 2003.

Other useful resource(s):

1. Link to NPTEL course contents: https://nptel.ac.in/courses/106104019/
2. Link to topics related to course:
   i. https://nptel.ac.in/courses/106104019/1
   ii. https://nptel.ac.in/courses/106104019/4
   iii. https://nptel.ac.in/courses/106104019/26
   iv. https://nptel.ac.in/courses/106104019/2Ev

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Parallel and Distributed Algorithms)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	**1.72**
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	**2.00**
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	**1.75**
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	**2.08**
Average	**2.0**	**2.5**	**2.5**	**2.5**	**2.5**	**1.0**	**1.0**	**1.0**	**2.0**	**2.25**	**1.5**	**2.0**	

Appendix-II (c)

Optoelectronic Devices

COURSE CODE: 18B1WPH831

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Engineering Physics-II

Course Objectives:

6. To enable the students to get better understanding about Photonic materials and their applications.
7. To familiarize students for making proper selection of Microwave devices for different applications.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	To define and explain the physics governing laser behaviour and light matter interaction.	Familiarity
CO-2	To calculate properties of and design modern optical waveguides, microwave waveguides, photonic crystals fibers and microwave hybrid circuits.	Problem Solving/ Assesment
CO-3	To approach and solve new problems in a range of advanced topics in Non linear optics	Usage
CO-4	To understand important and unique engineering issues at microwave and millimeter wave frequencies.	Familiarity
CO-5	To learn the applications of the microwave devices in the design of useful systems such as radars, receivers, etc.	Usage

Course Contents:

Unit	Contents	Lectures required
1	**Photonics:** Optical sources, modulators and detectors: Introduction, laser sources, semiconductor sources, electro-optic modulator, magneto-optic modulator, and acousto-optic modulator. Photoconductive detectors, photodiodes.	10
2	**Waveguides:** Optical waveguides: Introduction, planar waveguides, integrated optics, cylindrical waveguides, optical fibers for communication, photonic crystal fibers.	4
3	**Non-linear optics:** Introduction, formalism of non-linear optics, second harmonic generation and phase matching, optical mixing, intensity dependent refractive index, non-linear effects in photonic crystal fibers. Antireflective coating, optical fiber current measurement, integrated optical spectrum analyzer, holography, optical fiber amplifier, optical fiber laser.	10
4	**Microwave waveguides:** Introduction, rectangular waveguides, circular waveguides, microwave cavities, microwave hybrid circuits.	2
5	**Microwave transistors and diodes:** Introduction, microwave bipolar transistor & microwave tunnel diodes, IMPATT diodes, Transferred electron devices (TED), Quantum electron devices, and hot electron devices.	9
6	**Microwave field effect transistor:** Introduction, junction field effect transistor, MESFET, MOSFET, HEMTS, CCDs, Transistors as memory devices.	4
7	**Microwave linear beam tubes (O-type):** Introduction, triode, tetrode, pentode, Klystron. Microwave crossed field tubes (M-type): Introduction, Magnetron oscillator, cylindrical magnetron, linear magnetron, voltage tunable magnetron, and frequency-agile coaxial magnetron	3
Total lectures		**42**

Suggested Text Book(s):

1. Chi H. Lee, Microwave Photonics, CRC Press, 2nd edition (2013).
2. Samuel Y. Liao, Microwave Devices & circuits , Prinston Hall 3rd edition (2015)..
3. Ralf Menzel, Photonics: Linear and Nonlinear Interactions of Laser Light and Matter, Springer Berlin Heidelberg 1st edition (2007).
4. S. M. Sze, Semiconductor Devices, John Wiley & Sons, 3rd edition (2006).

Suggested Reference Book(s):

1. Chuang, Shun Lien,Physics of Photonic Devices, John Wiley & Sons, 2nd edition (2009).
2. Sisodia M L, Microwave Circuits and Passive Devices, New Age International Publishers (2002).

Other useful resource(s):

1. Link to topics related to course:
   i. https://nptel.ac.in/courses/115102026/
   ii. https://nptel.ac.in/courses/115101008/
   iii. https://nptel.ac.in/courses/108101112/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Photonics and Microwave Devices)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	1	1	-	2				2		2	1.5
CO-2	3	3	3	3	2	2				2		2	2.5
CO-3	3	3	3	3	2	2				2		2	2.5
CO-4	3	2	1	1	1	2				1		2	1.6
CO-5	3	3	3	3	2	3				2		3	2.7
Average	2.8	2.6	2.2	2.2	1.4	2.2				1.8		2.2	

GENERAL MICROBIOLOGY

COURSE CODE: 18MS1BT111

COURSE CREDITS: 3

CORE

L-T-P: 3-0-0

Course Objectives

To acquaint the students with the development and techniques of microbiology useful in biotechnology industry. Scientific evaluation of various characteristics of microorganisms, their metabolism and role in various domains of life.

Course Assessment

Assessment	**Max. marks**	**Duration**	**Course Covered**
T1 Test	15	1 hr.	course covered upto T1
T2 Test	25	1.5 hrs.	course covered upto T2, including that covered upto T1
End Term Test	35	2 hrs.	Whole Syllabus
Teacher Assessment (Based on Assignments, quizzes etc.)	25	Entire semester	Information to be provided to the class time to time
Total	**100**		

Course Outcomes

CO I	To acquire the principles of Microbiology and fundamental concepts related to microbial classification and methods
CO II	Scientifically test the hypothesis provided under a given situation involving microbial world and demonstrate practical skills in basic microbiological techniques including growth and control of microorganisms.
CO III	Analyze and interpret the experiments/pathways relevant to Microbes
CO IV	Designate vital role of the microorganisms in the environment and their genetics and association with human beings.

CO V	Retrieve and use cotemporary information and industrial potential related to microbial world.

Topic Covered

S. No.	Unit	Topics Covered	Contact Hrs.
1	Introduction of Microbiology and Historical Perspective	Discovery of microbial world, Landmark discoveries relevant to the field of microbiology, Controversy over spontaneous generation, History and pioneers in Microbiology, Nomenclature and classification of microbes, Bacterial metabolism, Sterilization and disinfection, Role of microorganisms in transformation of organic matter and in the diseases	5
2	Methods in Microbiology	Isolation, description and identification of bacteria. Microscopy and Morphology of micro-organisms, Pure culture techniques, Theory and practice of sterilization, Principles of microbial nutrition, Enrichment culture techniques for isolation of microorganisms, Growth and nutrition of bacteria,	3
3	Microbial Taxonomy and Diversity	Bacteria, Archaea and their broad classification, Eukaryotic microbes: Yeasts, molds and protozoa, Viruses and their classification, Molecular approaches to microbial taxonomy	3
4	Microbial Growth And Control of microorganisms	Definition of growth, Growth curve, Mathematical expression of exponential growth phase, Measurement of growth and growth yields, Synchronous growth, Continuous culture, Effect of environmental factors on growth, Effect of physical and chemical agents, Evaluation of effectiveness of antimicrobial agents	7

5	Microbial Metabolism	Energetics: redox reactions and electron carriers, An overview of metabolism, Glycolysis, Pentose-phosphate pathway, Entner-Doudoroff pathway, Glyoxalate Pathway, The citric acid cycle, Fermentation, Aerobic and anaerobic respiration, Chemolithotrophy	7
6	Microbial Diseases	Human diseases caused by viruses, bacteria, and fungi; The epidemiology, pathogenesis, antigenic characteristics and laboratory diagnosis of disease The nature and Classification of viruses, Morphology virus structure, replication The genetics of viruses The pathogenicity of viruses Epidemiology of viral infections, Vaccines and antiviral drug	5
7	Microbial Genetics	Types of mutation, UV and chemical mutagens, Selection of mutants, Ames test for mutagenesis, Bacterial genetic system: transformation, conjugation, transduction, plasmids, transposons, DNA repair, Regulation of gene expression: repression and induction, Operon model, Bacterial genome with special reference to E. Coli, Retroviruses	7
8	Microbial Ecology And Industrial applications	Thermophiles, Alkaliphiles, Acidophiles, Halophiles, Psychrophies, Radiophiles, Fermented foods and beverages, Biofertilizers, Biopesticides, Biofuels and Bioenergy	5
	Total Number of Lectures		**42**

Methodology

The course will be covered through lectures. Apart from discussions on topics covered in lectures, assignments and numerical problems will also be given.

TEXT BOOKS

1	Prescott, Harley and Klein: Microbiology, 6th Edition, McGraw Hill 2005.

2	Pelczar, Chan and Krieg: Microbiology by; Tata McGraw Hill.

Suggested Text Book(s):

1	Madigan, M.T., Martinko, J.M., Parker, J: Brock Biology of Microorganisms. 10th Edition.: Publisher: Prentice Hall
2	Gerard J. Tortura, Berdell R. Funke, and Christine L: Microbiology An Introduction: Case. 8th Ed., Pearson/Benjamin Cummings, 2004.
3	Nester : Microbiology Study Guide McGraw Hill.
4	Black : Microbiology : Principles and Applications Prentice Hall
5	Principles of Population Genetics by Daniel L. Hartl and Andrew G. Clark

GENERAL MICROBIOLOGY LAB

COURSE CODE: 18MS7BT111

COURSE CREDITS: 1

CORE/ELECTIVE: CORE

L-T-P: 0-0-2

Pre-requisite: None

Course Objectives:

7. To gain experience in microbiological techniques used in study of microbes
8. To familiarize the students with basics of methods with experimental analysis

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO1	To familiarize the students with basic microbiology instruments in the lab and basic precautions to be taken.	Familiarity
CO2	To aware the students about basic microbiological techniques to study the	Assessment

	microorganisms.	
CO3	Able to analyze bacterial growth kinetics (homogeneous reaction) in the laboratory	Assessment
CO4	Able to understand the basis of microbial resistance against antibiotics and growth of pathogenic organisms.	Usage
CO5	To develop a strong foundation about microbes and their applications	Usage

List of Experiments

S.No	Description	Hours
1	**Microscopy and Instrumentation** **1.** To study the construction and working of compound microscope. **2.** Study of microbiology-lab instruments. (Operation of autoclave, LAF, hot air oven, Culture room fumigation using formalin).	
2	**Staining techniques** **3.** Gram's staining and test for differentiation of bacteria. **4.** To perform acid fast staining. **5.** To perform Lacto phenol Cotton Blue slide mounts for fungal culture.	
3	**6.** Preparation and sterilization of bacterial and fungal culture media (Nutrient broth, nutrient agar slant, potato dextrose agar)	
4	7. Streaking and plating methods for isolation of axenic culture of bacteria. **8.** Isolation and enumeration of bacteria from soil, water and air using serial dilution technique	
5	**9.** Study of bacterial growth kinetics using Turbidometry, **10.** Cell count using haemocytometer. **11**. Effects of various environmental factors such as the presence or absence of oxygen, temperature and pH on growth of microbes. **12.** Physical and chemical methods used to control the growth of	

	microbes and the growth of microbes on various selective and differential media. **13.** Filter paper disc method for evaluation of antibiotic resistant activity of bacteria. Antimicrobial Sensitivity Testing – The Kirby-Bauer Method	
6	**14.** Preparation of nutrient agar slants and glycerol stocks for preservation. **15.** Lyophilization and Glycerol stock of bacteria for long term preservation	
Total Lab hours		

Suggested/Resources:

1. Introduction to Microbiology : A Case-History Study Approach by John L. Ingraham, Catherine A. Ingraham, Hardcover: 816 pages, Publisher: Brooks Cole
2. Microbiology : A Laboratory Manual (7th Edition) by James Cappuccino, Natalie Sherman, Paperback: 544 pages, Publisher: Benjamin Cummings
3. Microbiology: A Laboratory Experience; Holly Ahern
4. Creative Commons License: Attribution-NonCommercial-ShareAlike CC BY-NC-SA

Suggested Reference (s):

1. Willey, Joanne, Linda Sherwood, Chris Woolverton. Prescott's Microbiology, 8th edition. New York: McGraw Hill, 2011. Print.
2. Willey, Joanne, Linda Sherwood, Chris Woolverton. Lab Excercises in Microbiology, 8th edition. New York: McGraw Hill, 2011. Print
3. James G. Cappuccino and Natalie Sherman. Microbiology: A Laboratory Manual, 7th edition. Benjamin Cummings, 2004. Print.

MOLECULAR GENETICS AND GENOMICS

COURSE CODE: 18MS1BT112

COURSE CREDITS: 3

CORE/ELECTIVE : CORE

L-T-P: 3-0-0

Pre-requisite: Molecular Biology, Biochemistry, Microbiology

Course Objectives

This is an advance course with objective expose students to the advanced topics of Molecular Cell Biology. Application of molecular biology and genetics in prognosis, diagnosis and understanding of human diseases

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Students will have a thorough understanding elements of biomolecules (DNA, RNA and protein)	Familiarity
CO-2	The students will know the vast amount of genome information in publically available databases and how to access and best utilize for practical purposes & sequencing, genome annotation, global gene cloning and gene expression technologies, comparative genomics, introduction to pharmacogenomics	Assessment
CO-3	Able to analyze the gene expression data sets to derive the biologically meaning information	Assessmen t
CO-4	Able to apply the knowledge of function genomics in public health	Usage

Topic Covered:

S. No.	Contents	Lecture required.
1	Introduction to Genetics, Genome, Transcriptome, Proteome	3
2	DNA: The Genetic Material. Genome. Replication, Unique aspects of eukaryotic replication, fidelity of replication, DNA damage, repair mechanisms, homologous and site-specific recombination,	6
3	Gene Expression: Transcriptome, Eukaryotic RNA polymerases, RNA synthesis and RNA processing in eukaryotes, RNA editing, splicing, and polyadenylation. Traciptional factors (Crz1, AflR)	6
4	Gene Expression: Proteome. Aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetase, and translational proof-reading, translational inhibitors, Post- translational modification of proteins.	6
5	Genomics. Genetic and physical mapping. Understanding of a genome sequence, Prokaryotic and eukaryotic genomes. Organization of human genome. Organellar genome. Genome sequencing- Pyrosequencing & Sequencing by reverse termination. Application of whole of transcripts sequencing.	6

6	Functional and Comparative Genomics. Transcripts/transcriptome analysis- Hybridization and sequencing based approaches. Serial Analysis of Gene Expression-SAGE, DNA- Microarray, Application of DNA Microarray, RT-PCR, etc	6
7	Basics of population Genetics. Single Nucleotide polymorphism. SNP screening platforms & analysis. Haplotyping: Concepts and Applications. Genetics of cancer Biology- role of Tumor proteins p53, tumor suppressor p53, or transformation-related protein 53 (TRP53). p53 isoforms. Association studies of p53 gene in different setting of cancers.	6
8	Biomarker. Pharmacogenomics: Concepts and Applications in healthcare. Role of genotype in drug metabolism. Identification & Utilisation of cancer bio-marker	3
	Total Contact Hours	**42**

Suggested Text Book(s):

1. Molecular Cell Biology by Lodish
2. Molecular Biology, PS Verma VK Agarwal
3. Principles of genetics / D. Peter Snustad, Michael J. Simmons Snustad, D. Peter
4. Discovering Genomics, proteomics & bioinformatics. Second edition by A Malcolm Campbell, Davidson College; Laurie J. Heyer Davidson College ; With Foreword by Francis S. Collins
5. Molecular Biology of the Gene (1987) Watson J. D., Hopking N., Robast J. and Steiz, J.
6. BIOINFORMATICS: A Practical Guide to the Analysis of Genes and Proteins (Third edition) Andreas D. Baxevanis & B. F. Francis Ouellette

Research and Review Articles:

1. Suggested Reference (s): Ronaghi M. Pyrosequencing sheds light on DNA sequencing. Genome Res. 2001
2. Jan;11(1):3-11. Review. PubMed PMID: 11156611
3. Schulze A, Downward J. Navigating gene expression using microarrays—a technology review. Nat Cell Biol. 2001 Aug;3(8):E190-5. Review. PubMed PMID: 11483980
4. Kim JB, Porreca GJ, Song L, Greenway SC, Gorham JM, Church GM, Seidman CE, Seidman JG. Polony multiplex analysis of gene expression (PMAGE) in mouse hypertrophic cardiomyopathy. Science. 2007 Jun 8;316(5830):1481-4. PubMed PMID: 17556586
5. MacBeath G, Schreiber SL. Printing proteins as microarrays for high-throughput function determination. Science. 2000 Sep 8;289(5485):1760-3. PubMed PMID: 10976071.
6. Shankar J, Wu TD, Clemons KV, Monteiro JP, Mirels LF, et al. (2011) Influence of 17b-Estradiol on Gene Expression of Paracoccidioides during Mycelia-to- Yeast Transition. PLoS ONE 6(12): e28402. doi:10.1371/journal.pone.0028402

7. Mary V. Relling, William E. Evans Nature. Author manuscript; available in PMC 2016 Jan 13.

MOLECULAR GENETICS AND GENOMICS LAB

COURSE CODE: 18MS7BT112

COURSE CREDITS: 1

CORE/ELECTIVE: CORE

L-T-P: 0-0-2

Pre-requisite: Molecular Biology, Biochemistry, Microbiology

Course Objectives:

1. The course is intended to provide hand on experiments on comparative and functional genomics. Students will able to carry out both basic bioinformatics work and function genomics work.
2. The course will explore that how different advance molecular biology techniques unravel the understanding of diseases at genetic level

Course Outcomes:

CO I	Students will have a thorough understanding of various genomic technologies SNP,, cDNA-PCR, etc
CO II	The students will know the vast amount of genome information in publically available databases and how to access and best utilize for practical purposes e.g., NCBI. DDBJ, EMBL.
CO III	Able to analyze the gene expression experimental data sets to derive the biologically meaning information
COIV	Identify, formulate, review research literature, and analyze complex
COV	Able to identify, formulate, review research literature, and analyze complex and asses health, safety, legal and issues

Experiments covered:

S.NO.	TITLE
1	Isolation of Genomic DNA from different organisms (prokaryotes, eukaryotes and higher eukaryotes).
2	Polymerase chain reaction

3	Detection of SNP through RFLP (Restriction Fragment Length Polymorphism).
4	Extraction of Total RNA from eukaryotic species.
5	Preparation of cDNA template from isolated RNA.
6	Pulsed Field Gel Electrophoresis (demonstration)
7	Designing of Primers from a given gene of interest using online tools.
8	Physical restriction mapping of gene of interest (In-silico).
9	Real-Time PCR to quantify expression of gene.

Suggested Text Book(s):

1. Methods in Molecular Biology. Starkey, Michael P. Elaswarapu, Ramnath. Genomics Protocols. 2000. Vol. 175. Humana Press
2. Sambrook, J., Fritsch, E. F., Manitiatis, T., Molecular Cloning: A Laboratory Manual, New York: Cold Spring Laboratory Press, 1998, 25—27.
3. Current Protocols in Molecular Biology. Frederick M. Ausubel. John Wiley & Sons Inc. 1988

BIOCHEMISTRY AND INTERMEDIARY METABOLISM

COURSE CODE: 18MS1BT113

COURSE CREDITS: 3

CORE/ELECTIVE: CORE

L-T-P: 3-0-0

Pre-requisite: Cell Biology, structural biology, chemistry

Course Objectives

1. This is an advance course with an objectiveto provide an understanding of the various biomolecules and their chemical properties.
2. This course also has an objective to learn the interaction of bio-chemicals and their consequences on maintenance of life supporting processes.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	To understand the fundamentals of various basic biomolecules present in organisms and their chemical structures.	Familiarity
CO-2	To understand the structural-functionalrelationship of biomolecules for sustainment of life processes.	Assessment
CO-3	To understand the metabolic pathways ofenergy production in living organism.	Assessment
CO-4	To understand the integration and regulation of various metabolic pathways of organism for maintenance of life supporting processes.	Usage

Topic Covered

	Contents	Lecture required.
1	General aspects of metabolism: Characteristics of metabolic pathways; Strategies used to study metabolic pathways, Laws of thermodynamics; Equilibrium constant and standard free energy change; Biological oxidation-reduction reactions; Standard reduction potential and its relationship with free energy change,	3
2	Carbohydrate Metabolism: Digestion and absorption of carbohydrates; Glycolysis; Entry of other monosaccharaides in glycolytic pathway; Gluconeogenesis; Citric acid cycle; Pentose phosphate pathway; Glucuronate pathway; Biosynthesis of lactose; Biosynthesis of oligosaccharides and glycoproteins; Glycogen metabolism and its regulation; Glycogen storage diseases and other genetic defects in carbohydrate metabolism; Regulation of carbohydrate metabolism; Metabolic adaptation in starvation and diabetes mellitus,	8
3	Mitochondrial ATP Synthesis; Electron carriers and their organization; Sequence of respiratory complexes; ATP synthase and mechanism of ATP synthesis Transport of equivalents of NADH produced in cytoplasm; FADH2 oxidation.Oxidative phosphorylation: Sites of phosphorylation; Inhibitors and uncouplers; Energetics and regulation of oxidative phosphorylation.	6
4	Plant-Specific Metabolic Pathways; General pathways: Photosynthesis and carbon fixation; Glyoxylate pathway	6
5	Lipid Metabolism; Major dietary lipids; Digestion and absorption of dietary lipids; Pathways of fatty acid oxidation; Oxidation of odd carbon number and unsaturated fatty acids; Significance and metabolism of ketone bodies; Biosynthesis of saturated and unsaturated fatty acids; Metabolism of triacylglycerols, glycerolipids, sphingolipids and cholesterol; Role of leptin in the regulation of lipid metabolism.	7

6	Amino Acid and Porphyrin Metabolism; Digestion of dietary proteins; General reactions in the degradation of amino acids; Essential and nonessential amino acids; Deamination and transamination reactions; Urea cycle; Glucogenic and ketogenic amino acids;	6
7	Nucleotide and Xenobiotic Metabolism; Degradation of nucleic acids: deoxyribonucleases and ribonucleases; Biosynthesis and degradation of purine and pyrimidine nucleotides.	6
	Total Contact Hours	**42**

Suggested Text Book(s):

1. Lehninger Principles of Biochemistry by David L. Nelson and Michael M. Cox
2. Harpers Illustrated Biochemistry by by Victor W. Rodwell, David A Bender, Kathleen M. Botham, Peter J. Kennelly, P. Anthony Weil
3. Lippincott Illustrated Reviews: Biochemistry by Denise R. Ferrier

BIOCHEMISTRY AND INTERMEDIARY METABOLISM LAB

COURSE CODE: 18MS7BT113

COURSE CREDITS: 1

CORE/ELECTIVE: CORE

L-T-P: 0-0-2

Pre-requisite: Cell Biology, chemistry

Course Outcomes:

1. The course is intended to provide hand on experiments on biochemistry. Students will able to carry out both qualitative and quantitative estimation of basic biomolecules of living organisms.
2. The course will also explore that how different advance biochemistry methods unravel
   the understanding and diagnosingvarious diseases at molecular level.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO I	To familiarize with basic biochemistry laboratory procedures and	Familiarity

	safety.	
CO II	To identify different biochemical molecules using basic biochemical tests and estimate their quantity in standard units.	Assessment
CO III	To quantitate the concentration of a biomolecule in given sample.	Assessment
COIV	To identify and analyze different bio-chemicals in different samples like body fluids, food material etc. and asses their information in relation to human health	Usage

Experiments covered:

S.NO.	TITLE
1	Spectroscopic analysis of various biomolecules and determination of absorption spectrum,
2	Isolation of polysaccharide (starch or glycogen) from the biological material,
3	Quantitative estimation of carbohydrate using biochemical methods,
4	Extraction of lipid/oil from plant material and determination of its saponification value and iodine number,
5	Estimation of phospholipids by Stewart's method,
6	Estimation of protein and sugar content of a glycoprotein;
7	Sub – cellular fraction of and isolation of nuclei and mitochondria from the tissue and identification by the marker enzymes,
8	Determination of molecular weight of proteins by gel filtration,
9	Poly-acraylamide Gel Electrophoresis of serum proteins,
10	Isoelectric focusing and 2D electrophoresis
11	Isolation and quantification of DNA from plant tissue.
12	Isolation and quantification of DNA from animal tissue.

Suggested Text Book(s):

1. Lab manual

2. An Introduction to Practical Biochemistry - David T Plummer
3. Practical Biochemistry, Principles and Techniques - Keith Wilson and John Walker
4. Practical Biochemistry-GeethaDamodaran K
5. E-portal of V-labs by Amrita University (vlab.amrita.edu)

RESEARCH METHODOLOGY AND INFERENTIAL STATISTICS

COURSE CODE: 18MS1BT114

COURSE CREDITS: 3

CORE/ELECTIVE: CORE

L-T-P: 3-0-0

Pre-requisite: Nil

Course Objectives:

The Objective of the course is to make the student aware of research, planning design and appropriate methodology for research. They will learn statistical treatment, analysis of data, interpretation of results and report writing and assessment.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	The student will aware of ware of the finer nuances and significance of research, selecting, Defining and planning a research problem	Familiarity and Basics
CO-2	The student will learn various types of sampling methods suitable for statistical treatment and drawing valid inferences	Technical and strategies
CO-3	Develop understanding of measure of dispersion, tools and techniques of setting and validating scientific and statistical hypothesis	Technical and application
CO-4	Will learn different type experimental designs and principles of experimental designs	Technical and application

CO-5	Understand the importance scientific communication and technical writing skills	Familiarity and Basics

Course Contents:

Unit	Contents	Lectures required
1	**Fundamentals of Research and Research Process** Meaning and objectives of research, Importance of knowing research methods, Type of research, Basic research process, Criteria of good research, General conditions for a research problem, Selecting a research problem, Necessity and techniques of defining a problem	5
2	**Sampling and Sampling methods** Introduction, Definitions, aim of sampling, Type of populations, Different type of sampling methods	4
3	**Measure of Dispersion** Definition, methods of computation, merits, demerits uses and properties of different measures of central tendency. Definition, Computation, merits, demerits uses and properties of different measures of dispersion. Relative measure of dispersion, coefficient of variation, standard error, Central limit Theorem	5
4	**Testing of Hypothesis** Statistical hypothesis, critical region, level of significance, power of test, degree of freedom, steps in testing a hypothesis, Applications of z, t and Chi square tests for testing hypothesis, chi-square test, Application of chi- square test	9
5	**Analysis of Variance** Fundamental principles of analysis of variance, portioning sum of squares and degree of freedom, test of significance, critical difference, method of calculating sum of squares	6
6	**Principles of Experimental designs** Basic definitions; Experiment, treatment, replication, Experimental material, Experimental units, Fisher's principles of experimental design; Advantages of replication, randomization, local control; Precision and accuracy. Experimental Designs CRD, RBD & Latin	9

	Square	
7	**Report writing, Interpretation and Assessment** Significance of report writing, steps in report writing, layout of research report, Types of reports, Mechanics of writing report, precaution for writing research reports, Technique and precautions in interpretation	5
Total lectures		**42**

Suggested Text Book(s):

1. Research Methodology: Methods and Techniques. CR Kothari, New Age International Publishers.
2. Biostaistics A Foundation For Analysis in Health Sciences: Wayne W. Daniel John Willey & Sons, INC
3. A handbook of Agricultural statistics: SRS Chandel Achal Prakashan Mandir

Suggested Reference Book(s):

1. An introduction to biostatistics A manual for students for health Sciences. P.S.S. Sundar Rao and J. Richard. Prentice Hall of India.
2. Introduction to biostatistics A textbook of Biometry. P. K. Banerjee. S Chand and company ltd

Other useful resource(s):

GLP AND BIOINSTRUMENTATION

COURSE CODE: 18MS1BT115

COURSE CREDITS: 3

CORE/ELECTIVE: CORE

L-T-P: 3-0-0

Pre-requisite: B.Sc./B. Tech 2nd year completed

Course Objectives

1. The Objective of the course is to make the student aware of good laboratory practices and various regulatory guidelines followed in Biotech/Pharmaceutical industry
2. This course covers both theory and practical aspects of modern instrumentation used for analysis in biological research.

Course Outcomes

S.No.	Course Outcomes	Level of Attainment
CO-1	Able to understand basic guidelines and importance of good laboratory practice	Familiarity
CO-2	To learn various safety aspect related to laboratory research	Assessment
CO-3	To be able to understand documentation and conduct of non clinical studies	Assessment
CO-4	Able to Understand basic instrumental principles involved in the operation of mass spectrometers, infrared spectrometers,and nuclear magnetic resonance spectrometers.	Usage
CO-5	To Develop necessary critical thinking skills in order to do data analysis and interpretation in relation to the research process	Usage
CO-6	To analyze various analytical data	Usage

Topic Covered

S. No.	Contents	Lecture required.
1	Historical background of GLPs (The different organizations that have developed GLPs, Focus of each set of GLPs. Common GLP terms and definitions),	3
2	*Overview,Purpose and Essential elements of GLP :* Safety in the Laboratory: Material safety, Environmental safety, Occupational hazardous safety management, Waste management and disposal, Emergency care, First aid in accidents and poisoning, *Facilities* (Animal care facilities, Separation and isolation of animals, Animal supply facilities, Facilities to handle test articles and control articles, Specimen / data storage.)	6
3	*Testing facilities operation* (Documenting SOPs, Labelling reagents and solutions, Methodologies for test system handling, Quarantine, separation, isolation, and disease control, Clean cages and adequate food and water	6

	for test systems, *Conduct of nonclinical studies* (The study protocol and its uses, Correct methods of amending protocols and dealing with deviations, Correct conduct of non-clinical studies)	
4	Theory, instrumentation and applications of Visible, UV, IR, NMR and MS spectroscopy. Simple spectroscopic problems, Circular Dichroism Spectroscopy	20
5	Chromatography (Ion exchange, Molecular Sieve, Affinity, Thin layer GC and HPLC), Radio isotope techniques: Detection and measurement of radioactivity, Geiger Muller counters, Scintillation counting, Autoradiography and RIA, Electron microscopy,	7
	Total Contact Hours	42

Reference Books

1. GLP Essentials: a Concise Guide to Good Laboratory Practices Milton. A. Anderson (2002)
2. Good Laboratory Practice Regulations / Edited by Sandy Weinberg 4th edition, (2007)
3. Identifications of Organic Compounds by R. M. Silverstein, John Wiley, 8th edition, 2015.
4. Practical Biochemistry, Principles and Techniques - Keith Wilson and John Walker (2009)

INTRODUCTION TO IPR

COURSE CODE: 18MS1BT116

COURSE CREDITS: 3

CORE/ELECTIVE: CORE

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

9. To provide an insight and understanding about intellectual properties and rights
10. Learn about procedures and methodologies for filling intellectual property protection
11. Learn strategies to use IPR for mass utilization.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	To enable students with basic concepts and knowledge of intellectual property rights.	Awarness
CO-2	Able to apply and execute different principles of bioethics and biosafety used in development of biotechnological products	Assessment

		and technical skills
CO-3	Able to understand about the mechanisms of different IP protections, registrations and applications	Technical
CO-4	To be capable of tackling all issues related to IP and commercialization	Assessment
CO-5	Able to learn the strategies for effective IP management	Analytical skills
CO-6	To apply the knowledge of IPR for the benefit generation and for mass utilization	Usage

Course Contents:

Unit	Contents	Lectures required
1	**OVERVIEW OF INTELLECTUAL PROPERTY**: Introduction of Intellectual properties and rights conferred .IPR in India and abroad.	4
2	**IP Tools**: Different types of IPR(Patents, copyrights and related rights, Trademark, Tradesecret, Integrated circuit layout, Geographical indications, Traditional knowledge, Industrial designs and PBR). Rationale of different IPR ,their mechanism of protection and provisions in Law for registration and maintenance Copyright and related Rights Trademark protection and registration Industrial design protection Geographical Indications New Plant Varieties Unfair competition	10
3.	**PATENT**: Patent and kind of inventions protected by a patent Patent document How to protect your inventions? Granting of patent Rights of a patent How extensive is patent protection? Why protect inventions by patents? Searching a patent Drafting of a patent Filing of a patent . Drafting Patent Application and	4

	Documentation Revocation of Patent, Litigation and Infringement	
4	**International Agreements** and Treaties: International IP treaties (Madrid Agreement, Trademark law treaty, Patent Law treaty etc.) WIPO WTO, and TRIPS. International agreements relevant to biotechnology-associated IP	8
5.	**ENFORCEMENT OF INTELLECTUAL PROPERTY RIGHT** Infringement of intellectual property rights Enforcement Measures Emerging issues in Biological sciences	4
6	**INTELLECTUAL PROPERTY rights and role in Biotechnolog** **Overview of Biotechnology** procedures and product developmen rotection Biotechnology Research and role of bioethics and biosafety for uct development. Case studies of Biotechnological products and others	6
7.	**IP Management** and Commercialization Strategies for management and bioentrepreneurship	4
Total lectures		**42**

Methodology

The course will be covered through lectures, presentations and vedios. Apart from discussions on topics covered through lectures and assignments, students have to carry out research paper analysis.

Suggested Text Book(s):

23. Intellectual Property Rights & Copyright By Bouchoux.

24. IPR, Biosafety and Bioethics Book by Deepa Goel and Shomini Parashar

25. T. M Murray and M.J. Mehlman,Encyclopedia of Ethical, Legal and Policy issues in Biotechnology, John Wiley & Sons 2000

Suggested Reference Book(s):

6. Intellectual Property Rights, the WTO and Developing Countries: The TRIPS ...Book by Carlos María Correa

7. Bioethics and Biosafety by M K Sateesh.

2nd SEMESTER (MS2)

IMMUNOLOGY AND IMUMUNOTECHNOLOGY

COURSE CODE: 18MS1BT211

COURSE CREDITS: 3

CORE/ELECTIVE: CORE

L-T-P: 3-0-0

Prerequisites: Basic Biology.

Course Objective:
The objectives are to familiarize the students with

1. Basics of Immunology: types of immunity, T-cells and B-cells, antigen-antibody reaction and major histocompatibility complex (MHC).
2. Mechanisms of regulation of immune responses and immunological tolerance.
3. Role played by immune response in: infectious diseases, autoimmunity, hypersensitivity reactions, immunodeficiency diseases and vaccines.
4. Different technology driven immunological applications in disease and health.

Course Outcome:
Students would gain in-depth knowledge of basic immunology and roles played by immune system in various common diseases, and immunological applications in health and disease. Students with plans to carry out higher studies should be able to relate and apply immunological principles in their research while students inclined towards industrial career should be able to envision themselves as a part of the R &D sector in the area of immunology.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	To understand the basic concepts of immunology.	Familiarity
CO-2	To understand the functions of components of the immune system and their role in the diagnostics.	Assessment
CO-3	To understand the roles played by immune response in: infectious diseases, autoimmunity and vaccines.	Assessment
CO-4	To understand the transfer of protective immunity, assessment of immune response and production of antibodies.	Assessment/ Usage
CO-5	To understand the basics of various immunotechnological techniques and their applications.	Assessment/Usage

Course Contents:

Unit	Contents	No. of Lectures = 42
1	**Fundamental concepts:** specificity, memory, discrimination of self from non-self, innate and acquired immunity, immune organs, tissues, cells. development and developmental defects of/in immune system, humoral and cell-mediated immune response, antigen recognition by immune system: recognition of antigens by T and B Cells.	6
2	**Immunoglobins and antigens**: immunoglobins: structure and function, immunoglobin classes, antigens, Immunogenicity, antigenicity, epitopes, haptens, mitogens, antigen-antibody interactions.	3
3	**Interaction of immune system with antigen:** antigen processing and presentation, MHCs, role of MHC molecules in antigen presentation and co-stimulatory signals.	4
4	**Cytokines:** structure and function, cytokine receptors, regulation of immune response, cytokine related diseases, diagnosis and therapeutic application of cytokines.	2
5	**Immune system in diseases:** Immune response and bacterial, parasitic and viral infections, congenital and acquired immunodeficiency; tolerance and autoimmune diseases, transplantation and tumor Immunology, diagnosis and therapeutic approaches.	6
6	**Vaccines:** active immunization: subunit vaccines; recombinant DNA and protein based vaccines, peptide vaccines, conjugate vaccines; passive Immunization: antibody, transfusion of immuno-competent cells, stem cell therapy; cell based vaccines, high throughput identification of pathogen specific potential antigens for vaccine development, Immunoinformatics and vaccine design, methods for evaluation of clinical immune response to vaccines**.**	5
7	**Immune studies *in vivo* animal models and human subjects:** Assessment of protective immunity, transfer of protective immunity, Assessment of immune responses in humans, adoptive transfer of lymphocytes and hematopoietic stem-cell transfers	4
8	**Production and engineering of antibodies:** Production of monoclonal and polyclonal antibodies, hybridoma technology, specific and cross reactivity, anti-immunoglobulin antibodies, antibody engineering, abzymes, antigen-antibody interaction as a basis of precipitation and agglutination reactions, blood typing, RIA, ELISA, Imaging-Immunohistochemistry, Immunoprecipitation and co-immunoprecipitation, Immunoblotting	6
9	**Detection, measurement and characterization of antibodies and their**	6

	use as research and diagnostic tools: Characterization and analysis of cellular and soluble immune components: Isolation and enrichment of specific immune cells, ELISPOT, Flow-cytometer and FACS for quantitative/qualitative analysis and sorting of different immune cell subsets, Cell functional assays- lymphoproliferation, Cell cytotoxicity, mixed lymphocyte reaction, apoptosis,	

Suggested Text Book(s):

1. Kindt, T.J., Goldsby, R.A. and Osborne, B.A. (2007). Kuby Immunology .W.H. Freeman and Co., New York, 7th Ed.
2. Kenneth Murphy, Charles A Janeway, Paul Travers and Mark Walport (2007) Immunobiology Garland Science, 8th Ed.
3. Abbas AK, Lichtman AH and Pillai S (2001) Cellular and Molecular Immunology; Elsevier, USA, 7th Ed.
4. Roit, I. (2012). Essential Immunology. Blackwell Scientific Publications, Oxford, 12th Ed.
5. Primrose SB, Twyman RM and Old RW (2002) Principle of gene manipulation. Wiley-Blackwell, UK, 6th Ed.
6. Chakravarty AK (2006) Immunology and Immunotechnology. Oxford University Press, 1st Ed.

IMMUNOLOGY AND IMMUNOTECHNOLOGY LAB

COURSE CODE: 18MS7BT211

COURSE CREDITS: 1

CORE/ELECTIVE: CORE

L-T-P: 0-0-2

Prerequisites: Basic Biology/ Immunology

Objective:

The objective is to familiarize students with the various immunological techniques that include antigen-antibody interactions, quantitation of antigens or antibody, ELISA, agglutination reactions etc.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO1	To understand, design, analyze and interpret experiments related to	Familiarity

	immunology and link practical knowledge to theoretical.	
CO2	To detect antigen and check quality/quantity of antigen.	Familiarity/Assessment
CO3	To check changes in the number of leucocytes, their isolation from the blood and identify cells secreting cytokines specific to antigens.	Familiarity/Assessment
CO4	To understand team work, ethics and work discipline.	Usage

List of Experiments:

S.No.	Experiments
1	To quantify the concentration of unknown antigen by radial Immunodiffusion (RID).
2	To determine the identity of antigen by double Immunodiffusion (DID).
3	To quantify the concentration of unknown antigen by rocket Immunoelectrophoresis.
4	To characterize the given antibody by Immunoelectrophoresis.
5	To determine the presence of antigen by Dot ELISA method.
6	To check antigen- antibody reaction by performing Direct and Indirect Coombs Test.
7	To quantify the amount of precipitation by Quantitative precipitation assay.
8	To perform latex agglutination test to detect an unknown antigen.
9	To separate mononuclear cells from peripheral blood
10	Assay for cellular apoptosis/proliferation.
11	To estimate the antibody titer using haemagglutination assay.
12	To determine Total Leukocytes Count (TLC) of the given blood sample.
13	To understand and learn the basic concepts of ELISPOT Assay. To learn about the procedure and various reagents involved in performing the assay. (Virtual lab)
14	To learn how to perform fluorescent antibody labelling. To know how to calculate the amount of fluorescent dye bound to protein with a

	spectrophotometer. (Virtual Lab)

Suggested Reference (s):

1. Lab Manual
2. Hay FC and Westwood OMR (2003) Practical Immunology, 4th Ed., Blackwell Publishing.
3. Barbara Detrick, John L Schmitz and Robert G Hamilton (2016). Manual of Molecular and Clinical Laboratory Immunology.
4. V.Lab (http://vlab.amrita.edu/?sub=3&brch70

BIOPROCESS TECHNOLOGY

COURSE CODE: 18MS1BT212

COURSE CREDITS: 3

CORE/ELECTIVE: CORE

L-T-P: 3-0-0

Pre-requisite: Microbiology, Biochemistry

Course Objectives:

1. Learn various bioprocess technology related terms and principles
2. Learn about microbial growth kinetics in various mode of fermentation
3. Learn about the principles and application of Sterilization and Fermentation
4. Develop an understanding of important concepts and design aspects of bioreactors and its functioning
5. Learn about the principle of scaling up and scaling down of bioprocesses
6. Learn about the principles and application of various separation techniques involved in bioproducts recovery
7. Learn about the production and recovery of various products through case studies

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Able to use correct biological terms to describe & analyze phenomena/ problems in bioprocesses	Familiarity

CO-2	Able to analyze bacterial growth kinetics (homogeneous reaction) in batch /continuous/ Fed-batch reactor and thermal death kinetics	Assessment
CO-3	Able to describe media formulation, mixing and process scale up and the related basic design calculations	Assessment
CO-4	Able to solve mathematical problems related to bioprocess phenomena including mixing, Mass transfer and sterilization	Assessment
CO-5	To develop a strong foundation about bioreactor designs and their applications	Usage
CO-6	Able to apply principles of various unit operations in designing and optimization of downstream processes	Usage

Course Contents:

S. No.	Unit	Topics Covered	Contact Hrs.
1	Introduction and Basic Concepts	Introduction to Bioprocess Technology, Isolation, screening, preservation and maintenance of industrially important microbes; Strain improvement; Fermentation economics	6
2	Cell Growth Kinetics	Cell number and Cell mass calculations, Media design for growth, Continuous, batch and fed-batch fermentation, Microbial growth kinetics, Kinetic models for cell growth, Substrate and product inhibited growth models, Factors affecting microbial growth, Cell and enzyme immobilization	7
3	Sterilization	Sterilization principles and practices; Thermal death kinetics; Media sterilization; batch and continuous sterilization; Air Sterilization	3
4	Upstream processing	Fermentation media; Media formulation; Aeration and agitation in bioprocess; Measurement and control of bioprocess parameters; Scale up and scale down process	6
5	Fermentation and	Types of fermentation: Solid substrate, surface and submerged fermentation; and	3

	Its Concepts	Biotransformation; Application	
6	Fermenter Designs	Criteria for ideal fermenter; Configuration; Bioreactor designs- mechanically agitated; Pneumatic and hydrodynamic fermenters. Whole Cell Immobilized Fermenters; Stability of microbial reactors.	4
7	Downstream processing	Introduction; Separation of insolubles: Filtration, Centrifugation, Sedimentation; Cell disruption; Liquid-liquid extraction; Precipitation; Purification by chromatographic techniques; Reverse osmosis and ultra filtration; Drying; Crystallization; Storage and packaging; Treatment of effluent and its disposal.	7
8	Case Studies	Industrial Production of Bioproducts: Ethanol, Acids (Citric, acetic, Lactic and gluconic), solvents (glycerol, acetone, butanol), Antibiotics (Penicillin, streptomycin, tetracycline), Semi-synthetic antibiotics, Amino acids (Lysine, glutamic acid), Single Cell Protein.	6
	Total Number of Lectures		**42**

Suggested Text Book(s):

1. Pauline M. Doran, “Bioprocess Engineering Principles”, 8th ed., Academic press, New York, 2003.
2. M.L. Shuler and F. Kargi, "Bioprocess Engineering--basic Concepts", 2nd Edn. Prentice-hall Of India Pvt Ltd (2008).
3. Peter F. Stanbury, Stephen J. Hall & A. Whitaker, "Principles of Fermentation Technology", Â Elsevier India Pvt Ltd. (2007).
4. Jackson AT., Bioprocess Engineering in Biotechnology, Prentice Hall, Engelwood Cliffs, 1991.

Suggested Reference (s):

1. Klaas Van’t Riet, Johannes Tramper, “Basic Bioreactor Design”, 2nd ed., Marcel Dekker, Inc., New York, 1991.
2. JE Bailey and DF Ollis, “Biochemical Engineering Fundamentals”, 2nd ed., McGraw-Hill Book Company, New York, 1986.
3. Mccabe L.Warren, Smith C. Julian and Peter Harriott, “Unit Operations of Chemical Engineering”, 6th ed., McGraw Hill International Edition, New York, 2001.
4. Comprehensive Biotechnology: The Principles, Applications and Regulations of Biotechnology in Industry, Agriculture and Medicine, Vol 1, 2, 3 and 4. Young M.M., Reed Elsevier India Private Ltd, India, 2004.

5. Mansi EMTEL, Bryle CFA. Fermentation Microbiology and Biotechnology, 2nd Edition, Taylor & Francis Ltd, UK, 2007.
6. Abhilasha S. Mathuriya, "Industrial Biochnology" 1st ed., Ane Books Pvt. Ltd., New Delhi, 2009.

Other useful resource(s):

1. NPTEL Course Content:
   i) Bioreactors by Prof. Suraish Kumar, IIT Madras https://nptel.ac.in/courses/102106053/
   ii) Industrial Biotechnology by Prof. Debabrata Das, IIT Kharagpur…. https://nptel.ac.in/courses/102105058/
   iii) Aspects of Biochemical Engineering by Prof. Debabrata Das, IIT Kharagpur https://nptel.ac.in/courses/102105064/

2. Link to topics related to course:
   i) Mass Transfer by Prof. Bishnupada Mandal, IIT Guwahati https://nptel.ac.in/courses/103103034/13#

BIOPROCESS TECHNOLOGY LAB

COURSE CODE: 18MS7BT212

COURSE CREDITS: 1

CORE/ELECTIVE: CORE

L-T-P: 0-0-2

Pre-requisite: Microbiology Lab, Biochemistry Lab

Course Objectives:

8. Provide exposure to the students with hands on experience on various practices in Bioprocess Technology.
9. Enable students to link the theoretical knowledge of bioprocess technology with the experiments.
10. Enable to Learn how to operate bench scale fermenter
11. Learn how to determine various Monod's Kinetics parameter
12. Learn how to recover the various bioproduct after their production
13. Learn how to characterize the products after their recovery

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment

CO-1	Able to apply practical knowledge to understand the various important process engineering aspects involved in biotechnology industries	Familiarity
CO-2	Able to design experiments and to analyze various data related to various practices in bioprocess technology and its interpretation and their documentation	Assessment
CO-3	Able to set up a fermentation for the various bioproducts production followed by the analysis and characterization of the synthesized bioproducts for further applications	Usage
CO-4	Able to understand and determine various growth kinetics parameters in a batch culture	Assessment and Usage
CO-5	Able to describe and to apply the principles of various unit operations such as sonication, centrifugation, filtration, precipitation etc. used in DSP	Assessment and Usage
CO-6	Able to work in a team to accomplish the experiments and to document the experiments properly in lab note books	Assessment

List of Experiments

S. No.	Description	Hours
1	Introduction of Lab and lab safety	1
2	Describe the various parts of the bench-top fermenter (bioreactor) along with their functions.	1
3	Batch fermentation using shake-flask for ethanol production by *Saccharomyces cerevisae*.	2
4	Isolation and screening of microbes of industrial importance	2
5	Medium Optimization for enhancing the enzyme production (C- and N-source)	2

6	To study growth kinetics parameters of *E. coli*. a) Specific growth rate (μ) h^{-1} b) Maximum specific growth rate (μ_m) h^{-1} c) Saturation constant (K_s) gm/l d) Growth yield coefficient ($Y_{x/s}$) gm cell/gm substrate. e) Productivity of biomass gm cell/litre/h.	4
7	Setting up of a fermentation process for the production of extracellular industrial enzyme from the selected microbe of industrial importance	1
8	Downstream processing of the industrial enzyme produced by the fermentation process. a) Clarification b) Yield estimation c) Concentration using salt-induced precipitation d) Dialysis e) Purity check through SDS-PAGE and specific activity determination	4
9	Disruption of yeast cells using sonication to recover intracellular Invertase enzyme	2
10	Determination of protein and enzyme content in the cell lysate after the cell disruption	2
11	Preparation of Immobilized yeast cells in calcium alginate beads	2
Total Lab hours		**24**

Suggested/Resources:

1. M.L. Shuler and F. Kargi, "Bioprocess Engineering--basic Concepts", 2nd Edn. Prentice-hall Of India Pvt Ltd (2008).
2. Lab Manual
3. Keith Wilson, John Walker, “Principles and Techniques of Biochemistry and Molecular Biology, 7th ed., Cambridge University Press, Singapore, 2010.
4. Raja Ghosh, “Principles of Bioseparation Engineering”, World Scientific Publishing Co. Pte. Ltd., Singapore, 2006.
5. Pauline M. Doran, “Bioprocess Engineering Principles”, 8th ed., Academic press, New York, 2003.
6. Peter F. Stanbury, Stephen J. Hall & A. Whitaker, "Principles of Fermentation Technology", Â Elsevier India Pvt Ltd. (2007).

7. Downstream Processing by Dr. Mukesh Doble, IIT Madras
   https://nptel.ac.in/courses/102106022/
8. http://iitd.vlab.co.in/?sub=63

PLANT AND ANIMAL BIOTECHNOLOGY

COURSE CODE: 18MS1BT213

COURSE CREDITS: 3

ELECTIVE/CORE: CORE

L-T-P: 3-0-0

Pre-requisite: Basic Understanding of Biology

Course Objectives:

1. The objective of this course is to introduce the student to basic plant and animal cell and tissue culture techniques and their application.
2. In animal tissue culture component, the course is designed to impart an understanding pertaining to why one needs animal cell cultivation, the basic ATC set-up, the biology of cultured cells, techniques to establish and propagate cell cultures of animal origin.
3. In plant tissue culture component, the course is designed to develop an understanding about the morphology of plant cell and its utilization through different techniques of plant tissue culture for propagation, conservation and production of different plant species and their products

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Able to understand about basics of growing plant and animal cell and tissue under in vitro conditions	Familiarity
CO-2	Basic understanding of techniques and technologies used for growing plant and animal cell	Assessment & Analytical Skills
CO-3	To enable students for applying the knowledge about basic techniques of plant tissue culture for developing products.	Technical Skills
CO-4	Able to learn the methodologies for analyzing, upscaling and commercialization of plant based products.	Assessment & Analytical Skills

CO-5	To understand functional assay at cellular level, cell morphology and survival, immunolabeling in animal cells	Awareness
CO-6	To provide insight about the usage of Plant and Animal biotechnology with ethics and safety for masses and environmental utilization	Usage

Course Contents:

Units	Contents	Lectures required
1	Plant structure, growth and development Introduction, definitions and history of plant cell and tissue culture Organization of tissue culture laboratory Cellular totipotency and cell differentiation, factors affecting differentiation	3
2	Isolation of single plant cells, suspension cultures, types of suspension cultures, Measurement of the growth in suspension cultures, Assessment of Viability of the cultured cells, bioreactors used for plant cell cultures	6
3	Type of cultures and their applications: Direct and indirect methods of culture; seed culture, embryo culture, organ culture, callus culture, somaclonal variation and applications	6
4	Somatic embryogenesis Micro-propagation and its applications, Advances in acclimatization of tissue cultured plants. Haploid and triploid production and applications Protoplast isolation and fusion and application Production of virus free plants through cell and tissue culture	3
5	Secondary metabolite production and bioconversions /biotransformation through plant cell cultures and plant stem cells	3
6	Introduction to human anatomy and Physiology, An overview of different Systems, organs and tissues of human body. Basics terms and definitions, historical background, Importance of animal cell culture technology, laboratory facilities-design, equipments and safety parameters, waste disposal in a cell culture set-up. Aseptic techniques for animal cell cultivation.	7
7	Cell culture technology: Basic requirement for growing animal cells - Cell culture reagents, media, media supplements, media preparation and sterilization, Defined-Undefined media, Complete-Incomplete media, Importance of Serum and Serum free Media,	7

	culture conditions. Maintenance of cell culture: Culturing, sub-culturing, passaging.	
8	Studying biological system using cell culture techniques: Functional assays based on cell culture: Cell morphology, Quantitation, Growth pattern, Cytotoxicity assays, Study of Cell Death: senescence, apoptosis and necrosis, Cell proliferation, Cell viability measurements, FISH. Immunolabeling of cells to study molecular expression pattern–Microscopy, Flow cytometry, Immunohistochemistry, etc. Application of Cell culture Technology Hybridoma technology for monoclonal antibody production.	7
Total Lectures		**42**

Suggested Text Book(s):

1. Michael Butler, "Animal Cell Culture and Technology", BIOS Scientific Publishers
2. John R.W. Masters, " Animal Cell Culture-A Practical Approach", Oxford University Press
3. R. Ian Freshney, "Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications".
4. Introduction to Plant biotechnology H S Chawala
5. Plant tissue culture: theory and Practice S.S.Bhojwani and M K Razadan
6. Plant tissue culture S.S.Bhojwani and M K Razadan
7. Elements of Biotechnology P K Gupta
8. Plant cell and tissue culture Narayan Swamy

Suggested Reference Book(s)

1. Molecular Biology of the Cell: by Bruce Alberts, 4th Edition 2002.
2. Lodish, et al. Molecular Cell Biology. 5th ed. New York, NY: W.H. Freeman and Company, 2003.

Other useful resource(s):

1. Link to NPTEL course contents: https://nptel.ac.in/
2. https://nptel.ac.in/courses/102103012/
3. https://nptel.ac.in/courses/102104059/
4. https://nptel.ac.in/courses/102103016/

PLANT AND ANIMAL BIOTECHNOLOGY LAB

COURSE CODE: 18MS7BT213

COURSE CREDITS: 1

CORE/ELECTIVE: CORE

L-T-P: 0-0-2

Pre-requisite: Basic Biology

Course Objectives:

1. The objective is to familiarize students with the various plant and animal cell culture techniques.
2. To provide experience in handling plant and animal cells or tissues under in vitro conditions.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO1	To understand, design, analyze and interpret experiments related to plant and animal cell culturing	Familiarity
CO2	To understand, design, analyze and interpret experiments related to Animal cell culture and link practical knowledge to theoretical	Analytical Skills
CO3	To understand, design, analyze and interpret experiments related to Plant tissue Culture and link practical knowledge to theoretical	Analytical Skills
CO4	Able to handle and perform experiments for in vitro growth and development of plant and animal cells	Technical Skills
CO5	To understand team work, ethics and work discipline.	Use

List of Experiments

S.No	Description	Hours
1	Laboratory Safety and Introduction to ATC	2
2	Fluid Transfer using aseptic technique	2

3	Preparation of stock media and filter sterilization	2
4	Handling and Sub culturing of animals cells	2
5	Cryopreservation and Revival of Cell culture	2
6	Assessment of cytotoxicity/Biological screening of herbal/synthetic molecules	2
7	Introduction to various equipments and their working in plant tissue culture lab setup and Preparation of stocks solutions, hormones culture medium	2
8	Establishment of Callus and Suspension cultures and measuring cell growth	2
9	Plant regeneration from callus and somatic embryogenesis	2
10	Microproapagation of different plant species by axillary shooting	2
11	Hardening or Acclimatization of cultured plantlets to field conditions	2
12	Meristem culture for virus elimination. Anther and pollen culture for haploid production	2
13	Protoplast isolation and determining the protoplast viability	2
Total Lab hours		**26**

Suggested/Resources:

1. Lab Manual
2. Plant Cell and Tissue Culture - A Tool in Biotechnology: Basics and Application (Principles and Practice) by: Karl-Hermann Neumann publisher: Springer
3. Tissue Culture for Plant Propagators by R.A. de Fossard
4. Plant Culture Media, Volume 1,Formulations and Uses by E.F. George
5. Micropropagation: Technology and Application by P.C. Debergh and R.H. Zimmerman Kluwer Academic Publishers
6. Virtual Lab. (http://vlab.amrita.edu)

BASIC BIOINFORMATICS

COURSE CODE: 18MS1BI214

COURSE CREDITS: 2

CORE/ELECTIVE: CORE

L-T-P: 2-0-0

Pre-requisite: Molecular Biology, Biochemistry

Course Objectives:

1. Background and need for bioinformatics
2. Learn sequence analysis techniques.
3. Learn sequence alignment-pairwise and multiple.
4. Apply phylogenetic analysis.
5. Application of bioinformatics in modern day research.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Knowledge of bioinformatics databases and resources	Familiarity
CO-2	Sequence analysis including pairwise sequence alignment	Assessment
CO-3	Sequence analysis using multiple sequence alignment	Assessment
CO-4	Sequence annotation by identifying motifs, domains, conserved regions, predicting secondary structure of protein sequences	Usage
CO-5	Perform phylogenetic analysis of protein sequences and RNA secondary structure prediction	Assessment

Course Contents:

S. No.	Unit	Topics Covered	Contact Hrs.
1	Introduction	Bioinformatics and its role in modern biology, Next generation sequencing	3
2	Pairwise sequence alignment techniques	Dot plots-word size and stringency method, Alignments (Needleman & Wunsch algorithm, Smith-Waterman algorithm-with advanced scoring systems), semi-global alignment, Statistics of sequence alignment score: E-value and P-value	8
3	Sequence	Sequence Alignment: Dot plots, Alignments	8

	Alignment	(Needleman & Wunsch algorithm, Smith-Waterman algorithm-with simple scoring systems), Multiple sequence alignment, Amino acid distance measures (PAM matrices, Blosum matrices)	
4	Database search	Database searching : FASTA, BLAST	8
5	Fundamental of sequence alignment	Sequence similarity: Basic concepts, similarity scores	7
6	Primer design	Principles, Programs for Primer Design	4
7	Distance measures	Nucleotide distance measures (simple counts method, Jukes-Cantor correction, Kimura 2 parameter correction);	4
8	Phylogenetic reconstruction	Introduction, distance method (UPGMA, NJ), parsimony method	7
9	Gene prediction	Principles and programs for Gene prediction.	2
10	Structural alignment of proteins	Sequence-dependent structure superposition: RMSD, Sequence-independent structure alignment, DALI, VAST, CE, TM-Align	2
11	Secondary structure and tertiary prediction methods	Chou-Fasman, PHD, PSIPRED Comparative modeling, threading,	7
12	RNA secondary structure prediction	Principles and programs for RNA secondary structure prediction	3
	Total Number of Lectures		**42**

Suggested Text Book(s):

1. Bioinformatics: D.W. Mount

2. Introduction to Bioinformatics by Arthur Lesk

3. Bioinformatics: Databases, tools and Algorithms by Orpita Bosu and Simminder Kaur Thukral

4. Knowledge discovery in Bioinformatics: Xiaouha Hu, Yi Pan

Suggested Reference (s):

1. Sousa et al., Bioinformatics Applications in Life Sciences and Technologies, 2016. PubMed PMID: PMC4870335

Other useful resource(s):

1. https://www.hindawi.com/journals/isrn/2013/615630/
2. https://www.sciencedirect.com/science/article/pii/S0888754317300551

BASIC BIOINFORMATICS LAB

COURSE CODE: 18MS7BI214

COURSE CREDITS: 1

CORE/ELECTIVE: CORE

L-T-P: 0-0-2

Pre-requisite: None

Course Objectives:

1. Understand the importance of bioinformatics
2. Application of various bioinformatics tools
3. Understand the connection of bioinformatics and biotechnology

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO1	Understand the use of various bioinformatics resources (NCBI, Expasy, Pfam)	Usage and familiarity
CO2	Understand tools in NCBI (BLAST types etc.)	Assessment
CO3	Understand various databases and tools in Expasy (Swissprot, PROSITE)	Assessment
CO4	Hands-on of pairwise sequence alignment tools-global and local	Assessment
CO5	Hands-on of multiple sequence alignment tools-global and local	Assessment
CO6	Hands-on of phylogenetic analysis tools and visualization	Assessment

List of Experiments

S.No	Description	Hours
1	NCBI-Exploration of different databases and tools	2
2	BLAST program in online page and standalone package	2
3	PubChem database, Use of Swiss-Prot, PROSITE and PFAM databases	2
4	Multiple sequence alignment (MSA) programs and viewers: ClustalW, Jalview in online mode	2
5	Use of MSA programs (ClustalW) as a standalone package	2
6	Use of structural databases like PDB and structure visualization using Pymol and Rasmol	2
7	EMBOSS, STADEN and STAMP packages for sequence analyses	2
8	Gene prediction methods- GENPRED, GenePred	2
9	Phylogenetic analysis methods and tree viewers: Phylip and Archaeopteryx	2
10	Use of Phylip software as standalone package, MrBayes etc.	2
11	KEGG and GO database	2
12	Homology modeling in MODELLER, Docking in PatchDock	2
13	Prediction of RNA secondary structure	2
14	Use of structural classification databases like SCOP, CATH, FSSP	2
Total Lab hours		**28**

Suggested/Resources:

1. Pevsner J.:Bioinformatics and Functional Genomics; Cold Spring Harbor Laboratory Press, New York.
2. Baxevanis AD & Oulette BFF: Bioinformatics – A practical guide to the Analysis of Genes and Proteins, Willey International publishers.

ENVIRONMENTAL BIOTECHNOLOGY

COURSE CODE: 18MS1BT215

COURSE CREDITS: 3

CORE/ELECTIVE: CORE

L-T-P: 3-0-0

Pre-requisite: Environmental pollution: Cause and remediation strategies

Course Objectives:

Environmental Biotechnology is a rapidly developing, increasingly important branch of science that has implications for both the prevention and cleans up of pollution in domestic and industrial waste streams. The environmental applications of biotechnology will be presented in detail and will be supported by examples from the national and international literature. Such environmental applications of biotechnology include: Bioremediation of pollutants, applications in agriculture, applications in sustainable development in various industries well as in detection and monitoring environmental deterioration.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO I	Students will become aware of concept and scope of environmental biotechnology.	Familiarity
CO II	Students will have knowledge different techniques of bioremediation of pollutants	Assessment
CO III	Students will acquire knowledge about application of biotechnological methods in agriculture to reduce environmental impact.	Assessment
CO IV	Student will have acquaintance use of bioresources and biotechnology in various industries for sustainable development	Usage
CO V	Students will have knowledge about biotechnological methods for detection and monitoring of environmental deterioration	Usage
CO VI	Can analyse case-studies representative of key areas of environmental biotechnology	Assessment

Topics Covered:

S. No.	Unit	Topics Covered	Contact Hrs.
1	Environmental Biotechnology	Concept, Scope, areas and examples on subject matter	2
2	Bioremediation	Fundamentals, Methods and strategies In situ and Ex situ bioremediation, (Bio)venting, (Bio)sparging, (Bio)stripping, (Bio)sorption barriers, Biofilters, Bioreactors, Case studies , Phytoremediation: Technical considerations, Types factors case studies	8
3	Hazardous Waste Management	Energy Resource Recovery from Hazardous Waste Medical waste, Electronic waste. Characterization of the Harmful Effects of Chemicals and Materials, and Fate of HM in Environment risk Assessment.	8
3	Environmental Protection Biological waste Treatment	: Thermochemical conversion of biomass: combustion, pyrolysis, gasification, catalysis. Composting, Vermocomposting, Incineration Landfill Recycling Windrow composting. Liquid waste treatment; Biofilters, activated sludge systems.	4
4	Environmental Biotechnology and Agriculture:	Bio fertilizers: Symbiotic systems between plants – microorganisms, Chemical pesticide, Biopesticides, Biological control of pests Plant growth promoting rhizobacteria (PGPR) – uses, practical aspects and problems in application Soil Enzymes – origin and range of enzymes in soil, methods of measurement and extraction of soil enzymes, interactions between agrochemical and soil enzymes.	8
5	Renewable energy and bio-based products	Bioconversion of biomass to fuels, liquid and gaseous biofuels production, modelling and economics, Polutry waste biomass, Bio adhesives, Biopolymers, Bio lubricants, Bio plastics, fibers and paper.	8
6	Detection of Pollutants and Environmental Monitoring:	Bio-Indicators or Biomarkers, Biosensors for Environmental Monitoring. Toxicity screening of samples using bioluminescence or fluorescence, Water quality monitoring, Atmospheric quality bio-monitoring, and. Soil-contamination bio-monitoring.	4
		Total Number of Lectures	**42**

Suggested Text Book(s):

1. Environmental Biotechnolgy MH. Fulekar
2. Environmental Biotechnology (By: Arvind Kumar)
3. Textbook of Environmental Biotechnology P.K. Mahapatra
4. Introduction To Environmental Biotechnology 3rd Edition (English, Paperback, A. K. Chatterji)

Suggested Reference (s):

1. Environmental Biotechnology: Theory and Application Gareth M. Evans (Author), Judith C. Furlong (Author)

2. Environmental Biotechnology" by Bhattacharya B C and Banerjee R

Other useful resource(s):

https://nptel.ac.in/course.php?disciplineId

=102

ELECTIVE-I

COURSE CODE: XXXXXXXX

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

MASTERS RESEARCH REVIEW SEMINAR

COURSE CODE: 18MS9BT211

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

3rd SEMESTER (MS3)

FOOD BIOTECHNOLOGY

COURSE CODE: 18MS1BT311

COURSE CREDITS: 3

CORE/ELECTIVE: CORE

L-T-P: 3-0-0

Pre-requisite: Basic Biology, Introduction to Biochemistry and microbiology

Course Objectives:

1. To understand the concept of food science, technology and safety issues.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Basic understanding of food chemistry and nutrition	Familiarity
CO-2	Able to understand the concept of biotechnology in food science	Assessment
CO-3	Able to apply technology in Processing of food products	Assessment
CO-4	Able to understand the safety issues and emerging technologies in food science	Usage

Course Contents:

S. No.	Topics Covered	Contact Hrs.
1	Food Components and their role in nutrition: Carbohydrates, Proteins, fats, anti-nutrients, phytochemicals,	3
2	Food Quality and hazards: Perception, organoleptics and relation of nutrition to health, Food hazards: Physical, chemical, microbial (parasitic and viral) and engineered hazards: their threats; methods for detection and documentation.	4
3	Food fermentation Nutritional value of fermented food, requirements of fermentation, Benefit of fermentation - nutritive value of fermented food, various substrate used in fermentation and different types of fermentation.	4
4	Starter culture Technology Definition, types, propagation of starter	4

	cultures, Quality and activity of starter , factors affecting quality of starters, defects, Preservation of starter cultures.	
5	Microorganisms in fermented foods LAB-taxonomy, role in preservation, and basic metabolism, LAB metabolism of carbohydrate and protein, Molds and Yeasts in food fermentation, Microbial changes in fermented foods.	4
6	Fermented Foods: Sauerkraut, soy based fermented products,	3
7	Fermented dairy products Cultured milk, yoghurt, cheese production and other fermented milk products,	3
8	Bread fermentation Baker's yeast importance in bread fermentation, production technology of baker's yeast,	3
9	Alcoholic beverages Production of beer, wine and vinegar,	4
10	Traditional fermented foods Idli, dosa and other traditional fermented foods.	3
11	Food safety issues of new biotechnologies HACCP, GMP, GAP, SPS, TQM, Six sigma, EIA and ISO. Food designing and processes: Advanced and conventional processing and preservation methods Food packaging and labelling (Nutritional claim and health claim),	4
12	Emerging Technologies used in functional food Food vehicles, Targeted delivery, Microencapslation and Nanotechnologies, Nutraceuticals	3
	Total Number of Lectures	**42**

Suggested Text Book(s):

1. Biochemistry Stryer 7thEdition Biochemistry by Berg JM, Tymoczko JL, and Stryer L, published by W.H. Freeman and Company
2. Microbiology 5th edition E.C.S. Chan, Michael J. Pelczar, Jr., Noel R. Krieg
3. Prescott's microbiology Willey, J. M., Sherwood, L., Woolverton, C. J., Prescott, L. M., and Willey, J. M. (2011). New York, McGraw-Hill.
4. Microbiology: An Introduction 12thEdition Gerard J. Tortora, Berdell R. Funke and Christine L. Case
5. Principles of Fermentation Technology 3rd Edition Peter Stanbury Allan Whitaker Stephen Hall
6. Fundamentals of Food Biotechnology Byong H. Lee John Wiley and Sons
7. Food Microbiology M. R. Adams and M. O. Moss
8. Basic Food Microbiology George J. Banwart
9. Fundamental Dairy Microbiology Prajapati, J.B.
10. Lehninger Principles of Biochemistry, 5thEdition David L. Nelson and Michael M Cox.

Other useful resource(s):

https://onlinecourses.nptel.ac.in/noc18_ar10/

preview

FOOD BIOTECHNOLOGY LAB

COURSE CODE: 18MS7BT311

COURSE CREDITS: 1

CORE/ELECTIVE: CORE

L-T-P: 0-0-2

Pre-requisite: Basic Biology, Introduction to Biochemistry and microbiology

Course Objectives:

1. The objective is to familiarize students with the technologies and processes in Food Science.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO1	To understand, design, analyze and interpret experiments related to food science and link practical knowledge to theoretical.	Technical & Analytical Skill
CO2	To understand, design, analyze and interpret experiments related to food microbes and fermented food products	Technical & Analytical Skill
CO3	To understand, design, analyze and interpret experiments related to quality and nutritional value of food commodities	Technical & Analytical Skill
CO4	To understand team work, ethics and work discipline.	Usage

List of Experiments

S.No	Description	Hours

1	Introduction to Food Science and Laboratory Safety	2
2	Isolation of food spoilage microorganisms	2
3	Studies on metabolic activities of starter cultures	2
4	Production of fermented dairy product (Curd)	2
5	Production of Mozzarella cheese using acidification method	2
6	Production of fermented beverages (wine)	2
7	Fermenting power of yeast	2
8	Estimation of saponification value	2
9	Determination of acidity of water	2
10	Determination of alkalinity/ hardness of water	2
11	Determination of gelatinization temperature range of different starches and effect of additives	2
12	Determination of proteins in food commodities	2
13	Determination of fats in food commodities	2
Total Lab hours		**26**

Suggested/Resources:

1. Laboratory Manual of Food Microbiology Neelima Garg, K L Garg and K.G. Mukerji
2. Protein measurementwith the Folin phenol reagent Lowry, O.H., Rosebrough, N.J., Farr, A.L., and Randall, R.J. (1951) J.Biol.Chem 193: 265.
3. Standard Methods for the Examination of Water and Wastewater AWWA, WEF, APHA, 1998,(Methods: 4500 B. Electrometric Method; 2320 B. Titration Method)
4. Chemistry for Environmental Engineering4th Edition Sawyer, C.N., McCarty, P.L., and Parkin, G.F. 2000, Tata McGraw-Hill Publishing Company Limited.
5. Measurement of the gassing power of Bakers' Yeast:Correlation between the dough volume and the incubationtime Walter Borzani, Vol.47, pp. 213-217
6. An Introduction to Practical Biochemistry, 3rd edition David T Plummer, McGraw-Hill, c. McGraw-Hill Book Company (U.K.) Ltd.,London. 1987.
7. "Experimental Biochemistry" Beedusashidharrao, Vijay Deshpande, I K International

Pvt.ltd; ISBN 81-88237-41-8.

8. Laboratory Manual in Biochemistry Jayaraman J; Wiley Eastern Limited. 2.
9. Test Method for Acidity, Saponification value, Ester value, Iodine value and Hydroxy value of Chemical products and Unsaponifiables. JIS K 0070-1992
10. Determination of Fat United States Department of Agriculture Food Safety and Inspection Service, Office of Public Health Science
11. The Anthrone Method for the Determination of Carbohydrates in Foods and in Oral Rinsing Thomas G. Ludwig and Hyman J.V. Goldberg1956
12. Manufacture cheese of mozzarella by direct acidification withreduced amounts of rennet and pepsin 1 R. Mickettsand N. F. Olson
13. Manual of methods of analysis of foods Food safety and standards authority of India, Ministry of Health and Family Welfare Government of India,New Delhi,2015

ENZYMOLOGY AND ENZYME TECHNOLOGY

COURSE CODE: 18MS1BT312

COURSE CREDITS: 3

CORE/ELECTIVE: CORE

L-T-P: 3-0-0

Pre-requisite: Biochemistry

Course Objectives:

1. Learn about basic aspects of enzymes and their function and structure
2. Learn about mechanisms of various enzyme catalyzed reactions
3. Learn about the important aspects of enzyme kinetics
4. Learn about the regulatory mechanism of enzymes
5. Learn about the potential applications of enzymes

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Able to understand basic concepts of enzymes	Familiarity

CO-2	Able to understand the mechanism of action in various enzyme catalyzed reactions	Assessment
CO-3	Able to understand kinetics of enzymes	Assessment
CO-4	Able to solve mathematical problems related to enzyme kinetics and inhibition	Assessment
CO-5	Able to understand about various regulatory mechanism of enzymes	Assessment
CO-6	Able to understand the present potential of enzyme in industrial and clinical application and improved activity of the enzyme using various molecular biology techniques.	Usage

Course Contents:

S. No.	Unit	Topics Covered	Contact Hrs.
1	Introduction to Enzymes	Basic concepts, classification of enzymes, Unit of activity, Criteria of purity of enzymes- Specific activity, Role of coenzymes. Protein and non-protein enzymes: Isozyme, Synzyme, Abzymes, Ribozymes and DNAzymes, Metallozymes, Metal activated enzymes, Coenzymes and Cofactors, Prosthetic group,	8
2	Characteristics of enzymes and their reactions	Enzyme structure hierarchy: Primary, Secondary, tertiary and quaternary. Active sites and allosteric sites. Nature of active site, identification of functional groups at active site, enzyme-substrate complex. Enzymes Specificity, Types of specificity	6
3	Enzyme Catalysis	Hypothesis of enzymatic reactions, lock and key hypothesis induced fit hypothesis, Mechanism of enzyme action: acid-base catalysis, covalent catalysis, metal ion catalysis, proximity and orientation effects, nucleophilic and electrophilic catalysis. Mechanism: Chymotrypsin, Lysozyme, Carboxypeptidase A, Ribonuclase, Zymogens.	8
4	Enzyme Kinetics	Kinetics of Enzyme Catalysed Reactions: Michaelis-Menten hypothesis, transformations of Michaelis-Menten equation and determination of Km & V_{max}, substrate inhibition and activation, multireactant enzymes, King and Altman method of deriving steady-state velocity equations, Kinetics of Enzyme inhibition, Kinetics of Allosteric enzymes	8

5	Regulation of Enzyme Activity	Brief account of enzyme induction and repression, Feedback Regulation, Allosteric regulation, covalent modification, Proteolytic activation, Effect of temperature and pH on rate of enzyme catalysed reaction. Mechanism of enzyme degradation. Application of enzymes in various synthetic reactions	7
6	Industrial and clinical applications of enzymes	Industrial Enzymes: Thermophilic enzymes, amylases, lipases, proteolytic enzymes. Cellulose degdrading enzymes, Enzymes in food, leather, meat industries. Clinical enzymes: Enzymes as thrombolytic agents, anti-inflamatory agents, Streptokinase, Asparaginase, Transaminases, Cholinesterases, Phosphatases, ELISA, Biosensors. Enzyme engineering.	5
	Total Number of Lectures		**42**

Suggested Text Book(s):

1. Devasena, T., "Enzymology", 1st ed., Oxford University Press, 2010.
2. Berg, J.M., Tymoczko, J.L. and Stryer, L., "*Biochemistry*", 5th ed., W.H. Freeman and Company, New York, 2002
3. Nelson D.L., Cox M.M., "Lehninger Principles of Biochemistry", 5th ed., W.H. Freeman and Company, New York, 2008.

Suggested Reference (s):

1. Pye, E.K. and Wingard, L.B., "*Enzyme Engineering II*", Plenum Press, 1974.
2. Illanes A, "Enzyme Biocatalysis", Springer Science, 2008.

Other useful resource(s):

2. NPTEL Course Content:

   iv) Enzyme Science and Engineering by Prof. Subhash Chand, IIT Delhi
   https://nptel.ac.in/courses/102102033/

ENZYMOLOGY AND ENZYME TECHNOLOGY LAB

COURSE CODE: 18MS7BT312

COURSE CREDITS: 1

CORE/ELECTIVE: CORE

L-T-P: 0-0-2

Pre-requisite: Biochemistry Lab

Course Objectives:

1. Provide exposure to the students with hands on experience on various practices in Enzymology and Enzyme Technology.
2. Enable students to link the theoretical knowledge of Enzymology and Enzyme Technology with the experiments.
3. Enable to Learn how to carry out enzyme assays
4. Learn how to determine various Michaelis Menten's Kinetics parameter
5. Learn how to characterize an purified enzyme practically
6. Learn about the influence of various physicochemical characteristics upon enzyme activity

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Able to apply practical knowledge to understand the various important aspects of enzymes usage in biotechnology industries	Familiarity
CO-2	Able to design experiments and to analyze various data related to various practices in enzymology and enzyme technology and its interpretation and their documentation	Assessment
CO-3	Able to understand and determine various kinetics parameters of an enzyme	Usage
CO-4	Able to plot graphs and its interpretation	Assessment and Usage
CO-5	Able to perform immobilization of enzyme	Assessment and Usage
CO-6	Able to work in a team to accomplish the experiments and to document the experiments properly in lab note books	Assessment

List of Experiments

S. No.	Description	Hours

1	Introduction of Lab and lab safety	2
2	Determination of enzyme activity and specific activity of purified amylase enzyme	2
3	To analyze the effect of temperature on the enzyme activity	2
4	To analyze the effect of pH on the enzyme activity	2
5	To analyze the effect of metal ions on enzyme activity	2
6	To determine the thermostablity of the given enzyme	2
7	To determine the energy of activation of amylase enzyme	2
8	To determine Michaelis Menten's kinetics parameters of amylase enzyme	2
9	Determination of molecular weight using SDS-PAGE	2
10	Fractionation of enzyme by using ammonium sulphate precipitation	2
11	Preparation of Immobilized enzymes using calcium alginate beads and its characterization in term of activity and stability	4
Total Lab hours		**24**

Suggested/Resources:

1. Devasena, T., "Enzymology", 1st ed., Oxford University Press, 2010.
2. Lab Manual
3. Berg, J.M., Tymoczko, J.L. and Stryer, L., "*Biochemistry*", 5th ed., W.H. Freeman and Company, New York, 2002
4. Nelson D.L., Cox M.M., "Lehninger Principles of Biochemistry", 5th ed., W.H. Freeman and Company, New York, 2008.
5. Nicholas C. Price and Lewis Stevens, "Fundamental of Enzymology", Oxford University Press, Oxford. ISBN: 9780198502296.
6. Sawney S.K., Singh R. "Introductory Practical Biochemistry", Narosa Publisher, 2000. ISBN 9788173193026.

RECOMBINANT DNA TECHNOLOGY

COURSE CODE: 18MS1BT313

COURSE CREDITS: 3

CORE/ELECTIVE: CORE

L-T-P: 3-0-0

Pre-requisite: Genetics, Molecular Biology

Course Objectives:

1. Familiarize the students with the basic concepts in recombinant DNA technology
2. Acquaint the students to versatile tools and techniques employed in genetic engineering and recombinant DNA technology
3. Apprise students about applications recombinant DNA technology and genetic engineering

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Students will become aware of concept of recombinant DNA technology and genetic engineering and its applications	Familiarity and Basics
CO-2	Students will have knowledge of tools and strategies used in recombinant DNA technology	Technical and strategies
CO-3	Student will acquire knowledge about gene libraries and isolation of genes, DNA and genome sequencing technologies	Technical and application
CO-4	Student will have acquaintance about protein expression hosts and genetic manipulation of plants and animals	Familiarity and Basics
CO-5	Understand application of recombinant DNA technology and genetic engineering in problem solving in academic and industrial perspective	Application

Course Contents:

Unit	Contents	Lectures required

1	Introduction: Genetic engineering, Recombinant DNA technology: gene cloning - concept and basic steps - rDNA Glossary	2
2	DNA modifying enzymes and cloning techniques: Restriction Endonucleases, DNA Ligation Enzymes and, DNA, Gene cloning methods and strategies: Cloning of PCR products, TA and TOPO TA cloning, Gateway cloning, DNA Modifying Enzymes: Nucleases, Kinases, phosphatases, Reverse transcriptase, RFLP and AFLP	8
3	Cloning and Expression Vectors: Plasmid Vectors, Vectors based on Lambda Bacteriophage, Cosmids, M13 Vectors, Vectors for Cloning Large DNA Molecules, Expression Vectors, Transcriptional & Translational Fusions, Adding Tags and Signals overproducing Proteins.	10
4	Construction & Screening of genomic libraries: Genomic library, cDNA library, Growing & Storing Libraries, cDNA Cloning (5'&3' RACE)	5
5	Identification and isolation of genes: Screening Libraries with Gene Probes, Screening Expression Libraries with Antibodies, Susbtacrtive hybridization, DDRT-PCR, Positional Gene Cloning, Functional Complementation	4
6	DNA and Genome Sequencing: Basics of DNA Sequencing, Next generation sequencing technologies, Whole genome sequencing	6
7	Gene Expression in Microbial and Eukaryotic Systems: Microbial, Yeast *Saccharomyces Cerevisiae* and Other Fungi as heterologoues protein expression platforms	3
8	Genetic Manipulation of Plants and Animals: Gene transfer methods, Application of Genetically Engineered Strains of Plants and Animals	4
Total lectures		**42**

Suggested Text Book(s):

1. Principles of Gene Manipulation and Genomics SEVENTH EDITION S.B. Primrose and R.M. Twyman.
2. Recombinant DNA: A Short Course by JD Watson, J. Tooze and DT Kurtz.

3. Genetic Engineering : Amita Rastogi and Neelam Pathak

Suggested Reference Book(s):

1. From Genes to Genomes: Concepts and Applications of DNA Technology by JW Dale and M Schantz
2. Molecular Biotechnology: Principles & Applications of Recombinant DNA Glick BR and Pasternak JJ
8. Genetic Engineering : Amita Rastogi and Neelam Pathak

Other useful resource(s):

RECOMBINANT DNA TECHNOLOGY LAB

COURSE CODE: 18MS7BT313

COURSE CREDITS: 1

CORE/ELECTIVE: CORE

L-T-P: 0-0-2

Pre-requisite: None

Course Objectives:
The objective of the course is to give practical exposure to student about basic tools and techniques employed in recombinant DNA technology and genetic engineering.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO1	Students will be able to isolate and analyze plasmid vectors.	Technical
CO2	Students will be cut and ligate DNA fragments/vectors with help of restriction enzymes and ligase.	Technical
CO3	The students will be able to prepare competent cells and demonstrate bacterial transformation with given vectors	Technical
CO4	The students will be able to amplify specific DNA fragment and cloning it in T vectors demonstrate bacterial transformation.	Technical
CO5	Student will acquire proficiency in designing and conducting experiments involving genetic manipulation.	Strategies and Application

List of Experiments

S.No	Description	Hours
Lab-I	Introduction to rDNA laboratory, w.r.t. working bench, types of instruments and their handling, lab. Preparation of stock solutions of buffers for use in gel running, gel loading, their autoclaving; preparation of working buffers, antibiotic stocks, and storage of buffers required in rDNA practicals with detailed methodology. (Theory and Virtual)	**4**
Lab 2-3	Plasmid DNA Preparation: Preparation of LB medium with and without antibiotics for the growth of bacterial cultures, Growth of *E. coli*, Isolation of Plasmid DNA, Electrtrophoresis of Plasmid DNA and Interpretation of results	**4**
Lab 4	Restriction of given plasmid or λ DNA with the restriction enzyme *Eco*RI and HindIII or any other Restriction Enzymes,	**4**
Lab 4 -5	To perform ligation of λ/*Eco*R I digest using T4 DNA Ligase Electrophoresis of the uncut and digested DNA and Interpretation of the results Electrophoresis of ligated samples by agarose gel electrophoresis, Interpretation of the results	**4**
Lab 6	Setting up a PCR reaction to amplify a gene or a DNA fragment using gene specific primers	**2**
Lab 7	Preparation of competent cells of *E. coli* transformation	**4**
Lab 8	To insert the PCR product into T vector by TA-cloning, and confirmation	**4**
Lab 9-10	Transformation of E.coli. DH5 α cells with Empty puc/ pcambia1301/and Confirmation of transformed cells by scoring the expression of LacZ gene.	**4**
Lab 10-11	Transformation of E.coli. DH5 α cells with Recombinant T- vector/puc vector Confirmation of transformed cells by scoring the expression of LacZ gene.	**4**
Lab 12-13	RNA isolation and to synthesize cDNA from total RNA preparation using reverse transcriptase and oligod T primer (Virtual)	**2**
Lab 12-14	Mini Project for lab evaluation and Exam	**4**
Total Lab hours Total Contact Hours (Students are required to devote some extra time for some experiments		

Suggested/Resources:

1. Lab Manual
2. Molecular Cloning: A Laboratory Manual 2nd Edition Cold Spring Harbour

Laboratory Press

3. Virtual Lab

ELECTIVE-II

COURSE CODE: XXXXXXXX

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

MASTER'S RESEARCH THESIS PART-I

COURSE CODE: 18MS9BT311

COURSE CREDITS: 4

CORE/ELECTIVE: ELECTIVE

L-T-P: 0-0-8

4th SEMESTER (MS4)

MASTER'S RESEARCH THESIS PART-II

COURSE CODE: 18MS9BT411

COURSE CREDITS: 13

CORE/ELECTIVE: CORE

L-T-P: 0-0-26

Semester One

Biochemistry

Credits

3

Course Objectives

The objectives of this course are to build upon undergraduate level knowledge of biochemical principles with specific emphasis on different metabolic pathways. The course shall make the students aware of various disease pathologies within the context of each topic.

Student Learning Outcomes

On completion of this course, students should be able to:

- Gain fundamental knowledge in biochemistry;
- Understand the molecular basis of various pathological conditions from the perspective of biochemical reactions.

Unit I

Chemical basis of life

7 lectures

Chemical basis of life: Miller-Urey experiment, abiotic formation of amino acid oligomers, composition of living matter; Water – properties of water, essential role of water for life on earth pH, buffer, maintenance of blood pH and pH of gastric juice, pH optima of different enzymes (pepsin, trypsin and alkaline phosphatase), ionization and hydrophobicity, emergent properties of biomolecules in water, biomolecular hierarchy, macromolecules, molecular assemblies.

Unit II

Protein structure

4 lectures

Structure-function relationships: amino acids – structure and functional group properties, peptides and covalent structure of proteins, elucidation of primary and higher order structures, Ramachandran plot, evolution of protein structure, protein degradation and introduction to molecular pathways controlling protein degradation, structure-function relationships in model proteins like ribonuclease A, myoglobin, hemoglobin, chymotrypsin *etc.*; basic principles of protein purification; tools to characterize expressed proteins; Protein folding: Anfinsen's Dogma, Levinthal paradox, cooperativity in protein folding, free energy landscape of protein folding and pathways of protein folding, molten globule state, chaperons, diseases associated with protein folding, introduction to molecular dynamic simulation.

Unit III

Enzyme kinetics

5 lectures

Enzyme catalysis – general principles of catalysis; quantitation of enzyme activity and efficiency; enzyme characterization and Michaelis-Menten kinetics; relevance of enzymes in metabolic regulation, activation, inhibition and covalent modification; single substrate enzymes; concept of catalytic antibodies; catalytic strategies with specific examples of proteases, carbonic anhydrases, restriction enzymes and nucleoside monophosphate kinase; regulatory strategies with specific example of hemoglobin; isozymes; role of covalent modification in enzymatic activity; zymogens.

Unit IV

Glycobiology

2 lectures

Sugars - mono, di, and polysaccharides with specific reference to glycogen, amylose and cellulose, glycosylation of other biomolecules - glycoproteins and glycolipids; lipids - structure and properties of important members of storage and membrane lipids; lipoproteins.

Unit V

Structure and functions of DNA & RNA and lipids

3 lectures

Self-assembly of lipids, micelle, biomembrane organization - sidedness and function; membrane bound proteins - structure, properties and function; transport phenomena; nucleosides, nucleotides, nucleic acids - structure, a historical perspective leading up to the proposition of DNA double helical structure; difference in RNA and DNA structure and their importance in evolution of DNA as the genetic material.

Unit VI

Bioenergetics

8 lectures

Bioenergetics-basic principles; equilibria and concept of free energy; coupled interconnecting reactions in metabolism; oxidation of carbon fuels; recurring motifs in metabolism; Introduction to GPCR, Inositol/DAG//PKC and Ca++ signaling pathways;

glycolysis and gluconeogenesis; reciprocal regulations and non-carbohydrate sources of glucose; Citric acid cycle, entry to citric acid cycle, citric acid cycle as a source of biosynthetic precursors; Oxidative phosphorylation; importance of electron transfer in oxidative phosphorylation; F1-F0 ATP Synthase; shuttles across mitochondria; regulation of oxidative phosphorylation; Photosynthesis – chloroplasts and two photosystems; proton gradient across thylakoid membrane; Calvin cycle and pentose phosphate pathway; glycogen metabolism, reciprocal control of glycogen synthesis and breakdown, roles of epinephrine and glucagon and insulin in glycogen metabolism; Fatty acid metabolism; protein turnover and amino acid catabolism; nucleotide biosynthesis; biosynthesis of membrane lipids and sterols with specific emphasis on cholesterol metabolism and mevalonate pathway; elucidation of metabolic pathways; logic and integration of central metabolism; entry/ exit of various biomolecules from central pathways; principles of metabolic regulation; steps for regulation.

Unit VII
Role of vitamins & cofactors in metabolism
12 lectures

Calvin cycle and pentose phosphate pathway; glycogen metabolism, reciprocal control of glycogen synthesis and breakdown, roles of epinephrine and glucagon and insulin in glycogen metabolism; Fatty acid metabolism; protein turnover and amino acid catabolism; nucleotide biosynthesis; biosynthesis of membrane lipids and sterols with specific emphasis on cholesterol metabolism and mevalonate pathway; elucidation of metabolic pathways; logic and integration of central metabolism; entry/ exit of various biomolecules from central pathways; principles of metabolic regulation; steps for regulation; target of rapamycin (TOR) & Autophagy regulation in relation to C & N metabolism, starvation responses and insulin signaling.

Recommended Textbooks and References:

1. Stryer, L. (2015). *Biochemistry*. (8th ed.) New York: Freeman.
2. Lehninger, A. L. (2012). *Principles of Biochemistry* (6th ed.). New York, NY: Worth.
3. Voet, D., & Voet, J. G. (2016). *Biochemistry* (5th ed.). Hoboken, NJ: J. Wiley & Sons.
4. Dobson, C. M. (2003). *Protein Folding and Misfolding*. Nature, 426(6968), 884-890. doi:10.1038/nature02261.
5. Richards, F. M. (1991). *The Protein Folding Problem*. Scientific American, 264(1), 54-63. doi:10.1038/scientificamerican0191-54.

Cell and Molecular Biology

Credits
3

Course Objectives

The objectives of this course are to sensitize the students to the fact that as we go down the scale of magnitude from cells to organelles to molecules, the understanding of various biological processes becomes deeper and inclusive.

Student Learning Outcomes

Student should be equipped to understand three fundamental aspects in biological phenomenon: a) what to seek; b) how to seek; c) why to seek?

Unit I
Dynamic organization of cell
6 lectures

Universal features of cells; cell chemistry and biosynthesis: chemical organization of cells; internal organization of the cell - cell membranes: structure of cell membranes and concepts related to compartmentalization in eukaryotic cells; intracellular organelles: endoplasmic reticulum and Golgi apparatus, lysosomes and peroxisomes, ribosomes, cellular cytoskeleton, mitochondria, chloroplasts and cell energetics; nuclear compartment: nucleus, nucleolus and chromosomes.

Unit II **Chromatin structure and dynamics** 12 lectures	Chromatin organization - histone and DNA interactome: structure and assembly of eukaryotic and prokaryotic DNA polymerases, DNA-replication, repair and recombination; chromatin control: gene transcription and silencing by chromatin-Writers,-Readers and –Erasers; Transcriptional control: Structure and assembly of eukaryotic and prokaryotic RNA Polymerases, promoters and enhancers, transcription factors as activators and repressors, trancriptional initiation, elongation and termination; post-transcriptional control: splicing and addition of cap and tail, mRNA flow through nuclear envelope into cytoplasm, breakdown of selective and specific mRNAs through interference by small non-coding RNAs (miRNAs and siRNAs), protein translation machinery, ribosomes-composition and assembly; universal genetic codes, degeneracy of codons, Wobble hypothesis; Iso-accepting tRNA; mechanism of initiation, elongation and termination; co- and post-translational modifications, mitochondrial genetic code translation product cleavage, modification and activation.
Unit III **Cellular signalling, transport and trafficking** 3 lectures	Molecular mechanisms of membrane transport, nuclear transport, transport across mitochondria and chloroplasts; intracellular vesicular trafficking from endoplasmic reticulum through Golgi apparatus to lysosomes/cell exterior.
Unit IV **Cellular processes** 8 lectures	Cell cycle and its regulation; cell division: mitosis, meiosis and cytokinesis; cell differentiation: stem cells, their differentiation into different cell types and organization into specialized tissues; cell-ECM and cell-cell interactions; cell receptors and trans-membrane signalling; cell motility and migration; cell death: different modes of cell death and their regulation.
Unit V **Manipulating and studying cells** 3 lectures	Isolation of cells and basics of cell culture; observing cells under a microscope, different types of microscopy; analyzing and manipulating DNA, RNA and proteins.
Unit VI **Genome instability and cell transformation** 8 lectures	Mutations, proto-oncogenes, oncogenes and tumour suppressor genes, physical, chemical and biological mutagens; types of mutations; intra-genic and inter-genic suppression; transpositions- transposable genetic elements in prokaryotes and eukaryotes, role of transposons in genome; viral and cellular oncogenes; tumor suppressor genes; structure, function and mechanism of action; activation and suppression of tumor suppressor genes; oncogenes as transcriptional activators.

Recommended Textbooks and References:

1. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2008). *Molecular Biology of the Cell* (5th Ed.). New York: Garland Science.
2. Lodish, H. F. (2016). *Molecular Cell Biology* (8th Ed.). New York: W.H. Freeman.
3. Krebs, J. E., Lewin, B., Kilpatrick, S. T., & Goldstein, E. S. (2014). *Lewin's Genes XI*. Burlington, MA: Jones & Bartlett Learning.
4. Cooper, G. M., & Hausman, R. E. (2013). *The Cell: a Molecular Approach* (6th Ed.). Washington: ASM ; Sunderland.
5. Hardin, J., Bertoni, G., Kleinsmith, L. J., & Becker, W. M. (2012). *Becker's World of the Cell*. Boston (8th Ed.). Benjamin Cummings.
6. Watson, J. D. (2008). *Molecular Biology of the Gene* (5th ed.). Menlo Park, CA: Benjamin/Cummings.

Plant and Animal Biotechnology

Credits

2

Course Objectives

The objectives of this course are to introduce students to the principles, practices and application of animal biotechnology, plant tissue culture, plant and animal genomics, genetic transformation and molecular breeding of plants and animals.

Student Learning Outcomes

Students should be able to gain fundamental knowledge in animal and plant biotechnology and their applications.

Unit I

Plant tissue culture and animal cell culture

10 lectures

Plant tissue culture: historical perspective; totipotency; organogenesis; Somatic embryogenesis; establishment of cultures – callus culture, cell suspension culture, media preparation – nutrients and plant hormones; sterilization techniques; applications of tissue culture - micropropagation; somaclonal variation; androgenesis and its applications in genetics and plant breeding; germplasm conservation and cryopreservation; synthetic seed production; protoplast culture and somatic hybridization - protoplast isolation; culture and usage; somatic hybridization - methods and applications; cybrids and somatic cell genetics; plant cell cultures for secondary metabolite production.
Animal cell culture: brief history of animal cell culture; cell culture media and reagents; culture of mammalian cells, tissues and organs; primary culture, secondary culture, continuous cell lines, suspension cultures; application of animal cell culture for virus isolation and *in vitro* testing of drugs, testing of toxicity of environmental pollutants in cell culture, application of cell culture technology in production of human and animal viral vaccines and pharmaceutical proteins.

Unit II

Plant genetic manipulation

10 lectures

Genetic engineering: *Agrobacterium*-plant interaction; virulence; Ti and Ri plasmids; opines and their significance; T-DNA transfer; disarmed Ti plasmid; Genetic transformation - *Agrobacterium*-mediated gene delivery; cointegrate and binary vectors and their utility; direct gene transfer - PEG-mediated, electroporation, particle bombardment and alternative methods; screenable and selectable markers; characterization of transgenics; chloroplast transformation; marker-free methodologies; advanced methodologies - cisgenesis, intragenesis and genome editing; molecular pharming - concept of plants as biofactories, production of industrial enzymes and pharmaceutically important compounds.

Unit III

Animal reproductive biotechnology and vaccinology

8 lectures

Animal reproductive biotechnology: structure of sperms and ovum; cryopreservation of sperms and ova of livestock; artificial insemination; super ovulation, embryo recovery and *in vitro* fertilization; culture of embryos; cryopreservation of embryos; embryo transfer technology; transgenic manipulation of animal embryos; applications of transgenic animal technology; animal cloning - basic concept, cloning for conservation for conservation endangered species; Vaccinology: history of development of vaccines, introduction to the concept of vaccines, conventional methods of animal vaccine production, recombinant approaches to vaccine production, modern vaccines.

Unit IV

Plant and animal genomics

4 lectures

Overview of genomics – definition, complexity and classification; need for genomics level analysis; methods of analyzing genome at various levels – DNA, RNA, protein, metabolites and phenotype; genome projects and bioinformatics resources for genome research – databases; overview of forward and reverse genetics for assigning function for genes.

Unit V

Molecular mapping and marker assisted selection

8 lectures

Molecular markers - hybridization and PCR based markers RFLP, RAPD, STS, SSR, AFLP, SNP markers; DNA fingerprinting-principles and applications; introduction to mapping of genes/QTLs; marker-assisted selection - strategies for Introducing genes of biotic and abiotic stress resistance in plants: genetic basis for disease resistance in animals; molecular diagnostics of pathogens in plants and animals; detection of meat adulteration using DNA based methods.

Recommended Textbooks and References:

1. Chawla, H. S. (2000). *Introduction to Plant Biotechnology*. Enfield, NH: Science.
2. Razdan, M. K. (2003). *Introduction to Plant Tissue Culture*. Enfield, NH: Science.
3. Slater, A., Scott, N. W., & Fowler, M. R. (2008). *Plant Biotechnology: an Introduction to Genetic Engineering*. Oxford: Oxford University Press.
4. Buchanan, B. B., Gruissem, W., & Jones, R. L. (2015). *Biochemistry & Molecular Biology of Plants*. Chichester, West Sussex: John Wiley & Sons.
5. Umesha, S. (2013). *Plant Biotechnology*. The Energy And Resources.
6. Glick, B. R., & Pasternak, J. J. (2010). *Molecular Biotechnology: Principles and Applications of Recombinant DNA*. Washington, D.C.: ASM Press.
7. Brown, T. A. (2006). *Gene Cloning and DNA Analysis: an Introduction*. Oxford: Blackwell Pub.
8. Primrose, S. B., & Twyman, R. M. (2006). *Principles of Gene Manipulation and Genomics*. Malden, MA: Blackwell Pub.
9. Slater, A., Scott, N. W., & Fowler, M. R. (2003). *Plant Biotechnology: The Genetic Manipulation of Plants*. Oxford: Oxford University Press.
10. Gordon, I. (2005). *Reproductive Techniques in Farm Animals*. Oxford: CAB International.
11. Levine, M. M. (2004). *New Generation Vaccines*. New York: M. Dekker.
12. Pörtner, R. (2007). *Animal Cell Biotechnology: Methods and Protocols*. Totowa, NJ: Humana Press.

Microbiology

Credits

2

Course Objectives

The objectives of this course are to introduce field of microbiology with special emphasis on microbial diversity, morphology, physiology and nutrition; methods for control of microbes and host-microbe interactions.

Student Learning Outcomes

Students should be able to:

- Identify major categories of microorganisms and analyze their classification, diversity, and ubiquity;
- Identify and demonstrate structural, physiological, genetic similarities and differences of major categories of microorganisms;
- Identify and demonstrate how to control microbial growth;
- Demonstrate and evaluate interactions between microbes, hosts and environment.

Unit I

Microbial characteristics

6 lectures

Introduction to microbiology and microbes, history & scope of microbiology, morphology, structure, growth and nutrition of bacteria, bacterial growth curve, bacterial culture methods; bacterial genetics: mutation and recombination in bacteria, plasmids, transformation, transduction and conjugation; antimicrobial resistance.

Unit II

Microbial diversity

9 lectures

Microbial taxonomy and evolution of diversity, classification of microorganisms, criteria for classification; classification of bacteria; Cyanobacteria, acetic acid bacteria, Pseudomonads, lactic and propionic acid bacteria, endospore forming bacteria,

Mycobacteria and Mycoplasma. Archaea: Halophiles, Methanogens, Hyperthermophilic archae, Thermoplasm; eukarya: algae, fungi, slime molds and protozoa; extremophiles and unculturable microbes.

Unit III
Control of microorganisms
3 lectures

Sterilization, disinfection and antisepsis: physical and chemical methods for control of microorganisms, antibiotics, antiviral and antifungal drugs, biological control of microorganisms.

Unit IV
Virology
5 lectures

Virus and bacteriophages, general properties of viruses, viral structure, taxonomy of virus, viral replication, cultivation and identification of viruses; sub-viral particles – viroids and prions.

Unit V
Host-microbes interaction
5 lectures

Host-pathogen interaction, ecological impact of microbes; symbiosis (Nitrogen fixation and ruminant symbiosis); microbes and nutrient cycles; microbial communication system; bacterial quorum sensing; microbial fuel cells; prebiotics and probiotics.

Recommended Textbooks and References:

1. Pelczar, M. J., Reid, R. D., & Chan, E. C. (2001). *Microbiology* (5th ed.). New York: McGraw-Hill.
2. Willey, J. M., Sherwood, L., Woolverton, C. J., Prescott, L. M., & Willey, J. M. (2011). *Prescott's Microbiology*. New York: McGraw-Hill.
3. Matthai, W., Berg, C. Y., & Black, J. G. (2005). *Microbiology, Principles and Explorations*. Boston, MA: John Wiley & Sons.

Genetics

Credits

2

Course Objectives

The objectives of this course are to take students through basics of genetics and classical genetics covering prokaryotic/ phage genetics to yeast and higher eukaryotic domains. On covering all classical concepts of Mendelian genetics across these life-forms, students will be exposed to concepts of population genetics, quantitative genetics encompassing complex traits, clinical genetics and genetics of evolution.

Student Learning Outcomes

On successful completion of this course, student will be able :

- Describe fundamental molecular principles of genetics;
- Understand relationship between phenotype and genotype in human genetic traits;
- Describe the basics of genetic mapping;
- Understand how gene expression is regulated.

Unit I
Genetics of bacteria and bacteriophages
10 lectures

Concept of a gene in pre-DNA era; mapping of genes in bacterial and phage chromosomes by classical genetic crosses; fine structure analysis of a gene; genetic complementation and other genetic crosses using phenotypic markers; phenotype to genotype connectivity prior to DNA-based understanding of gene.

Unit II
Yeast genetics
6 lectures

Meiotic crosses, tetrad analyses, non-Mendelian and Mendelian ratios, gene conversion, models of genetic recombination, yeast mating type switch; dominant and recessive genes/mutations, suppressor or modifier screens, complementation groups, transposon mutagenesis, synthetic lethality, genetic epistasis.

Unit III
Drosophila genetics as a model of higher eukaryotes
4 lectures

Monohybrid & dihybrid crosses, back-crosses, test-crosses, analyses of autosomal and sex linkages, screening of mutations based on phenotypes and mapping the same, hypomorphy, genetic mosaics, genetic epistasis in context of developmental mechanism.

Unit IV
Population genetics and genetics of evolution
4 lectures

Introduction to the elements of population genetics: genetic variation, genetic drift, neutral evolution; mutation selection, balancing selection, Fishers theorem, Hardy-Weinberg equilibrium, linkage disequilibrium; in-breeding depression & mating systems; population bottlenecks, migrations, Bayesian statistics; adaptive landscape, spatial variation & genetic fitness.

Unit V
Quantitative genetics of complex traits (QTLs)
2 lectures

Complex traits, mapping QTLs, yeast genomics to understand biology of QTLs.

Unit VI
Plant genetics
2 lectures

Laws of segregation in plant crosses, inbreeding, selfing, heterosis, maintenance of genetic purity, gene pyramiding.

Recommended Textbooks and References:

1. Hartl, D. L., & Jones, E. W. (1998). *Genetics: Principles and Analysis*. Sudbury, MA: Jones and Bartlett.
2. Pierce, B. A. (2005). *Genetics: a Conceptual Approach*. New York: W.H. Freeman.
3. Tamarin, R. H., & Leavitt, R. W. (1991). *Principles of Genetics*. Dubuque, IA: Wm. C. Brown.
4. Smith, J. M. (1998). *Evolutionary Genetics*. Oxford: Oxford University Press.

Basics of Mathematics and Statistics

Credits
2

Course Objectives

The objective of this course is to give conceptual exposure of essential contents of mathematics and statistics to students.

Student Learning Outcomes

On completion of this course, students should be able to :

- Gain broad understanding in mathematics and statistics;
- Recognize importance and value of mathematical and statistical thinking, training, and approach to problem solving, on a diverse variety of disciplines.

Unit I
Algebra
6 lectures

Linear equations, functions: slopes-intercepts, forms of two-variable linear equations; constructing linear models in biological systems; quadratic equations (solving, graphing, features of, interpreting quadratic models *etc.*), introduction to polynomials, graphs of binomials and polynomials; Symmetry of polynomial functions, basics of trigonometric functions, Pythagorean theory, graphing and constructing sinusoidal functions, imaginary numbers, complex numbers, adding-subtracting-multiplying complex numbers, basics of vectors, introduction to matrices.

Unit II
Calculus
4 lectures

Differential calculus (limits, derivatives), integral calculus (integrals, sequences and series *etc.*).

Unit III
Mathematical models in biology
4 lectures

Population dynamics; oscillations, circadian rhythms, developmental patterns, symmetry in biological systems, fractal geometries, size-limits & scaling in biology, modeling chemical reaction networks and metabolic networks.

Unit IV
Statistics
5 lectures

Probability: counting, conditional probability, discrete and continuous random variables: Error propagation; Populations and samples, expectation, parametric tests of statistical significance, nonparametric hypothesis tests, linear regression, correlation & causality, analysis of variance, factorial experiment design.

Recommended Textbooks and References:

1. Stroud, K. A., & Booth, D. J. (2009). *Foundation Mathematics*. New York, NY: Palgrave Macmillan.
2. Aitken, M., Broadhursts, B., & Haldky, S. (2009) *Mathematics for Biological Scientists*. Garland Science.
3. Billingsley, P. (1986). *Probability and Measure*. New York: Wiley.
4. Rosner, B. (2000). *Fundamentals of Biostatistics*. Boston, MA: Duxbury Press.
5. Daniel, W. W. (1987). *Biostatistics, a Foundation for Analysis in the Health Sciences*. New York: Wiley.

Basics of Chemistry and Physics

Credits

2

Course Objectives

The objectives of this course are to cover all essentials required to appreciate physico-chemical principles underlying biological processes.

Student Learning Outcomes

Students should be able to have a firm foundation in fundamentals and application of current chemical and physical scientific theories.

Unit I
Basic physics for biologists
12 lectures:
10 hours teaching +
2 hours tutorials

Physical quantities and their dynamics: definitions and dimensions; vectors & scalars, displacement, velocity, acceleration, kinematic formulas, angular momentum, torque *etc.* force, power, work, energy (kinetic & potential/electric charge separation, electromagnetic spectrum, photons *etc.*); springs & Hookes laws; elastic and inelastic collisions; Newton's law of motions (centripetal and centrifugal forces *etc.*); simple harmonic motions, mechanical waves, Doppler effect, wave interference, amplitude, period, frequency & wavelength; diffusion, dissipation, random walks, and directed motions in biological systems; low Reynolds number - world of Biology, buoyant forces, Bernoulli's equation, viscosity, turbulence, surface tension, adhesion; laws of thermodynamics: Maxwell Boltzmann distribution, conduction, convection and radiation, internal energy, entropy, temperature and free energy, Maxwell's demon (entropic forces at work in biology, chemical assemblies, self-assembled systems, role of ATP); Coulomb's law, conductors and insulators, electric potential energy of charges, nerve impulses, voltage gated channels, ionic conductance; Ohms law (basic electrical quantities: current, voltage & power), electrolyte conductivity, capacitors and capacitance, dielectrics; various machines in biology *i.e.* enzymes, allostery and molecular motors (molecules to cells and organisms).

Unit II
Basic chemistry for biologists

Basic constituents of matter - elements, atoms, isotopes, atomic weights, atomic numbers, basics of mass spectrometry, molecules, Avogadro number, molarity, gas constant, molecular weights, structural and molecular formulae, ions and polyatomic

12 lectures:
10 hours teaching +
2 hours tutorials

ions; chemical reactions, reaction stoichiometry, rates of reaction, rate constants, order of reactions, Arrhenious equation, Maxwell Boltzmann distributions, rate-determining steps, catalysis, free-energy, entropy and enthalpy changes during reactions; kinetic versus thermodynamic controls of a reaction, reaction equilibrium (equilibrium constant); light and matter interactions (optical spectroscopy, fluorescence, bioluminescence, paramagnetism and diamagnetism, photoelectron spectroscopy; chemical bonds (ionic, covalent, Van der Walls forces); electronegativity, polarity; VSEPR theory and molecular geometry, dipole moment, orbital hybridizations; states of matter - vapor pressure, phase diagrams, surface tension, boiling and melting points, solubility, capillary action, suspensions, colloids and solutions; acids, bases and pH - Arrhenious theory, pH, ionic product of water, weak acids and bases, conjugate acid-base pairs, buffers and buffering action *etc*; chemical thermodynamics - internal energy, heat and temperature, enthalpy (bond enthalpy and reaction enthalpy), entropy, Gibbs free energy of ATP driven reactions, spontaneity versus driven reactions in biology; redox reactions and electrochemistry - oxidation-reduction reactions, standard cell potentials, Nernst equation, resting membrane potentials, electron transport chains (ETC) in biology, coupling of oxidative phosphorylations to ETC; theories of ATP production and dissipation across biological membranes; bond rotations and molecular conformations - Newman projections, conformational analysis of alkanes, alkenes and alkynes; functional groups, optically asymmetric carbon centers, amino acids, proteins, rotational freedoms in polypeptide backbone (Ramachandran plot).



Recommended Textbooks and References:

1. Baaquie, B. E. (2000). *Laws of Physics: a Primer*. Singapore: National University of Singapore.
2. Matthews, C. P., & Shearer, J. S. (1897). *Problems and Questions in Physics*. New York: Macmillan Company.
3. Halliday, D., Resnick, R., & Walker, J. (1993). *Fundamentals of Physics*. New York: Wiley.
4. Ebbing, D. D., & Wrighton, M. S. (1990). *General Chemistry*. Boston: Houghton Mifflin.
5. Averill, B., & Eldredge, P. (2007). *Chemistry: Principles, Patterns, and Applications*. San Francisco: Benjamin Cummings.
6. Mahan, B. H. (1965). *University Chemistry*. Reading, MA: Addison-Wesley Pub.
7. Cantor, C. R., & Schimmel, P. R. (2004). *Biophysical Chemistry*. San Francisco: W.H. Freeman.

Laboratory I: Biochemistry & Analytical Techniques

Credits



Course Objectives

The objective of this laboratory course is to introduce students to experiments in biochemistry. The course is designed to teach students the utility of set of experimental methods in biochemistry in a problem oriented manner.

Student Learning Outcomes

On completion of this course, students should be able to:

- To elaborate concepts of biochemistry with easy to run experiments;
- To familiarize with basic laboratory instruments and understand the principle of measurements using those instruments with experiments in biochemistry.

Syllabus

1. Preparing various stock solutions and working solutions that will be needed for the course.

2. To prepare an Acetic-Na Acetate Buffer and validate the Henderson-Hasselbach equation.
3. To determine an unknown protein concentration by plotting a standard graph of BSA using UV-Vis Spectrophotometer and validating the Beer- Lambert's Law.
4. Titration of Amino Acids and separation of aliphatic, aromatic and polar amino acids by thin layer chromatography.
5. Purification and characterization of an enzyme from a recombinant source (such as Alkaline Phosphatase or Lactate Dehydrogenase or any enzyme of the institution's choice).
   a) Preparation of cell-free lysates
   b) Ammonium Sulfate precipitation
   c) Ion-exchange Chromatography
   d) Gel Filtration
   e) Affinity Chromatography
   f) Dialysis of the purified protein solution against 60% glycerol as a demonstration of storage method
   g) Generating a Purification Table (protein concentration, amount of total protein; Computing specific activity of the enzyme preparation at each stage of purification)
   h) Assessing purity of samples from each step of purification by SDS-PAGE Gel Electrophoresis
   i) Enzyme Kinetic Parameters: Km, Vmax and Kcat.
6. Experimental verification that absorption at OD_{260} is more for denatured DNA as compared to native double stranded DNA. reversal of the same following DNA renaturation. Kinetics of DNA renaturation as a function of DNA size.
7. Identification of an unknown sample as DNA, RNA or protein using available laboratory tools. (Optional Experiments)
8. Biophysical methods (Circular Dichroism Spectroscopy, Fluorescence Spectroscopy).
9. Determination of mass of small molecules and fragmentation patterns by Mass Spectrometry.

Laboratory II: Microbiology

Credits



Course Objectives

The objective of this laboratory course is to provide practical skills on basic microbiological techniques.

Student Learning Outcomes

Students should be able to:

- Isolate, characterize and identify common bacterial organisms;
- Determine bacterial load of different samples;
- Perform antimicrobial sensitivity tests;
- Preserve bacterial cultures.

Syllabus

1. Sterilization, disinfection and safety in microbiological laboratory.
2. Preparation of media for cultivation of bacteria.
3. Isolation of bacteria in pure culture by streak plate method.
4. Study of colony and growth characteristics of some common bacteria: *Bacillus, E. coli, Staphylococcus, Streptococcus, etc.*
5. Preparation of bacterial smear and Gram's staining.
6. Enumeration of bacteria: standard plate count.
7. Antimicrobial sensitivity test and demonstration of drug resistance.
8. Maintenance of stock cultures: slants, stabs and glycerol stock cultures
9. Determination of phenol co-efficient of antimicrobial agents.
10. Determination of Minimum Inhibitory Concentration (MIC)

11. Isolation and identification of bacteria from soil/water samples.

Recommended Textbooks and References:

1. Cappuccino, J. G., & Welsh, C. (2016). *Microbiology: a Laboratory Manual.* Benjamin-Cummings Publishing Company.
2. Collins, C. H., Lyne, P. M., Grange, J. M., & Falkinham III, J. (2004). *Collins and Lyne's Microbiological Methods* (8th ed.). Arnolds.
3. Tille, P. M., & Forbes, B. A. *Bailey & Scott's Diagnostic Microbiology.*

Laboratory III: Plant and Animal Biotechnology

Credits

2

Course Objectives

The objectives of this course are to provide hands-on training in basic experiments of plant and animal biotechnology.

Student Learning Outcomes

On completion of course, students should be able to gain basic skills in plant and animal biotechnology.

Syllabus

Plant Biotechnology

1. Prepare culture media with various supplements for plant tissue culture.
2. Prepare explants of *Valleriana wallichii* for inoculation under aseptic conditions.
3. Attempt *in vitro* andro and gynogenesis in plants *(Datura stramonium).*
4. Isolate plant protoplast by enzymatic and mechanical methods and attempt fusion by PEG (available material).
5. Culture *Agrobacterium tumefaciens* and attempt transformation of any dicot species.
6. Generate an RAPD and ISSR profile of *Eremurus persicus* and *Valleriana wallichii.*
7. Prepare karyotypes and study the morphology of somatic chromosomes of *Allium cepa, A. sativum, A. tuberosum* and compare them on the basis of karyotypes.
8. Pollen mother cell meiosis and recombination index of select species (one achiasmate, and the other chiasmate) and correlate with generation of variation.
9. Undertake plant genomic DNA isolation by CTAB method and its quantitation by visual as well as spectrophotometeric methods.
10. Perform PCR amplification of 'n' number of genotypes of a species for studying the genetic variation among the individuals of a species using random primers.
11. Study genetic fingerprinting profiles of plants and calculate polymorphic information content.

Syllabus

Animal Biotechnology

1. Count cells of an animal tissue and check their viability.
2. Prepare culture media with various supplements for plant and animal tissue culture.
3. Prepare single cell suspension from spleen and thymus.
4. Monitor and measure doubling time of animal cells.
5. Chromosome preparations from cultured animal cells.
6. Isolate DNA from animal tissue by SDS method.
7. Attempt animal cell fusion using PEG.

Semester Two

Genetic Engineering

Credits

3

Course Objectives

The objectives of this course are to teach students with various approaches to conducting genetic engineering and their applications in biological research as well as in biotechnology industries. Genetic engineering is a technology that has been developed based on our fundamental understanding of the principles of molecular biology and this is reflected in the contents of this course.

Student Learning Outcomes

Given the impact of genetic engineering in modern society, the students should be endowed with strong theoretical knowledge of this technology. In conjunction with the practicals in molecular biology & genetic engineering, the students should be able to take up biological research as well as placement in the relevant biotech industry.

Unit I
Introduction and tools for genetic engineering
6 lectures

Impact of genetic engineering in modern society; general requirements for performing a genetic engineering experiment; restriction endonucleases and methylases; DNA ligase, Klenow enzyme, T4 DNA polymerase, polynucleotide kinase, alkaline phosphatase; cohesive and blunt end ligation; linkers; adaptors; homopolymeric tailing; labelling of DNA: nick translation, random priming, radioactive and non-radioactive probes, hybridization techniques: northern, southern, south-western and far-western and colony hybridization, fluorescence *in situ* hybridization.

Unit II
Different types of vectors
7 lectures

Plasmids; Bacteriophages; M13 mp vectors; PUC19 and Bluescript vectors, hagemids; Lambda vectors; Insertion and Replacement vectors; Cosmids; Artificial chromosome vectors (YACs; BACs); Principles for maximizing gene expression expression vectors; pMal; GST; pET-based vectors; Protein purification; His-tag; GST-tag; MBP-tag *etc.*; Intein-based vectors; Inclusion bodies: methodologies to reduce formation of inclusion bodies; mammalian expression and replicating vectors; Baculovirus and *Pichia* vectors system, plant based vectors, Ti and Ri as vectors, yeast vectors, shuttle vectors.

Unit III
Different types of PCR techniques
7 lectures

Principles of PCR: primer design; fidelity of thermostable enzymes; DNA polymerases; types of PCR – multiplex, nested; reverse-transcription PCR, real time PCR, touchdown PCR, hot start PCR, colony PCR, asymmetric PCR, cloning of PCR products; T-vectors; proof reading enzymes; PCR based site specific mutagenesis; PCR in molecular diagnostics; viral and bacterial detection; sequencing methods; enzymatic DNA sequencing; chemical sequencing of DNA; automated DNA sequencing; RNA sequencing; chemical synthesis of oligonucleotides; mutation detection: SSCP, DGGE, RFLP.

Unit IV
Gene manipulation and protein-DNA interaction
7 lectures

Insertion of foreign DNA into host cells; transformation, electroporation, transfection; construction of libraries; isolation of mRNA and total RNA; reverse transcriptase and cDNA synthesis; cDNA and genomic libraries; construction of microarrays – genomic arrays, cDNA arrays and oligo arrays; study of protein-DNA interactions: electrophoretic mobility shift assay; DNase footprinting; methyl interference assay, chromatin immunoprecipitation; protein-protein interactions using yeast two-hybrid system; phage display.

Unit V
Gene silencing and genome editing technologies
13 lectures

Gene silencing techniques; introduction to siRNA; siRNA technology; Micro RNA; construction of siRNA vectors; principle and application of gene silencing; gene knockouts and gene therapy; creation of transgenic plants; debate over GM crops; introduction to methods of genetic manipulation in different model systems *e.g.* fruit flies

(*Drosophila*), worms (*C. elegans*), frogs (*Xenopus*), fish (zebra fish) and chick; Transgenics - gene replacement; gene targeting; creation of transgenic and knock-out mice; disease model; introduction to genome editing by CRISPR-CAS with specific emphasis on Chinese and American clinical trials.

Recommended Textbooks and References:

1. Old, R. W., Primrose, S. B., & Twyman, R. M. (2001). *Principles of Gene Manipulation: an Introduction to Genetic Engineering*. Oxford: Blackwell Scientific Publications.
2. Green, M. R., & Sambrook, J. (2012). *Molecular Cloning: a Laboratory Manual*. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.
3. Brown, T. A. (2006). *Genomes* (3rd ed.). New York: Garland Science Pub.
4. Selected papers from scientific journals, particularly Nature & Science.
5. Technical Literature from Stratagene, Promega, Novagen, New England Biolab *etc.*

Immunology

Credits

3

Course Objectives

The objectives of this course are to learn about structural features of components of immune system as well as their function. The major emphasis of this course will be on development of immune system and mechanisms by which our body elicits immune response. This will be imperative for students as it will help them to predict about nature of immune response that develops against bacterial, viral or parasitic infection, and prove it by designing new experiments.

Student Learning Outcomes

On completion of this course, students should be able to:

- Evaluate usefulness of immunology in different pharmaceutical companies;
- Identify proper research lab working in area of their own interests;
- Apply their knowledge and design immunological experiments to demonstrate innate, humoral or cytotoxic T lymphocyte responses and figure out kind of immune responses in the setting of infection (viral or bacterial).

Unit I

Immunology: fundamental concepts and overview of the immune system

5 lectures

Components of innate and acquired immunity; phagocytosis; complement and inflammatory responses; pathogen recognition receptors (PRR) and pathogen associated molecular pattern (PAMP); innate immune response; mucosal immunity; antigens: immunogens, haptens; Major Histocompatibility Complex: MHC genes, MHC and immune responsiveness and disease susceptibility, Organs of immune system, primary and secondary lymphoid organs.

Unit II

Immune responses generated by B and T lymphocytes

8 lectures

Immunoglobulins - basic structure, classes & subclasses of immunoglobulins, antigenic determinants; multigene organization of immunoglobulin genes; B-cell receptor; Immunoglobulin superfamily; principles of cell signaling; basis of self & non-self discrimination; kinetics of immune response, memory; B cell maturation, activation and differentiation; generation of antibody diversity; T-cell maturation, activation and differentiation and T-cell receptors; functional T Cell subsets; cell-mediated immune responses, ADCC; cytokines: properties, receptors and therapeutic uses; antigen processing and presentation- endogenous antigens, exogenous antigens, non-peptide bacterial antigens and super-antigens; cell-cell co-operation, Hapten-carrier system.

Unit III

Antigen-antibody interactions

6 lectures

Precipitation, agglutination and complement mediated immune reactions; advanced immunological techniques: RIA, ELISA, Western blotting, ELISPOT assay, immunofluorescence microscopy, flow cytometry and immunoelectron microscopy; surface plasmon resonance, biosensor assays for assessing ligand –receptor interaction; CMI techniques: lymphoproliferation assay, mixed lymphocyte reaction, cell cytotoxicity assays, apoptosis, microarrays, transgenic mice, gene knock outs.

Unit IV
Vaccinology
8 lectures

Active and passive immunization; live, killed, attenuated, subunit vaccines; vaccine technology: role and properties of adjuvants, recombinant DNA and protein based vaccines, plant-based vaccines, reverse vaccinology; peptide vaccines, conjugate vaccines; antibody genes and antibody engineering:chimeric, generation of monoclonal antibodies, hybrid monoclonal antibodies; catalytic antibodies and generation of immunoglobulin gene libraries, idiotypic vaccines and marker vaccines, viral-like particles (VLPs), dendritic cell based vaccines, vaccine against cancer, T cell based vaccine, edible vaccine and therapeutic vaccine.

Unit V
Clinical immunology
8 lectures

Immunity to infection : bacteria, viral, fungal and parasitic infections (with examples from each group); hypersensitivity: Type I-IV; autoimmunity; types of autoimmune diseases; mechanism and role of CD4+ T cells; MHC and TCR in autoimmunity; treatment of autoimmune diseases; transplantation: immunological basis of graft rejection; clinical transplantation and immunosuppressive therapy; tumor immunology: tumor antigens; immune response to tumors and tumor evasion of the immune system, cancer immunotherapy; immunodeficiency: primary immunodeficiencies, acquired or secondary immunodeficiencies, autoimmune disorder, anaphylactic shock, immunosenescence, immune exhaustion in chronic viral infection, immune tolerance, NK cells in chronic viral infection and malignancy.

Unit VI
Immunogenetics
5 lectures

Major histocompatibility complex genes and their role in autoimmune and infectious diseases, HLA typing, human major histocompatibility complex (MHC), Complement genes of the human major histocompatibility complex: implication for linkage disequilibrium and disease associations, genetic studies of rheumatoid arthritis, systemic lupus erythematosus and multiple sclerosis, genetics of human immunoglobulin, immunogenetics of spontaneous control of HIV, KIR complex.

Recommended Textbooks and References:

1. Kindt, T. J., Goldsby, R. A., Osborne, B. A., & Kuby, J. (2006). *Kuby Immunology*. New York: W.H. Freeman.
2. Brostoff, J., Seaddin, J. K., Male, D., & Roitt, I. M. (2002). *Clinical Immunology*. London: Gower Medical Pub.
3. Murphy, K., Travers, P., Walport, M., & Janeway, C. (2012). *Janeway's Immunobiology*. New York: Garland Science.
4. Paul, W. E. (2012). *Fundamental Immunology*. New York: Raven Press.
5. Goding, J. W. (1996). *Monoclonal Antibodies: Principles and Practice: Production and Application of Monoclonal Antibodies in Cell Biology, Biochemistry, and Immunology*. London: Academic Press.
6. Parham, P. (2005). *The Immune System*. New York: Garland Science.

Bioinformatics

Credits

2

Course Objectives

The objectives of this course are to provide theory and practical experience of the use of common computational tools and databases which facilitate investigation of molecular biology and evolution-related concepts.

Student Learning Outcomes

Student should be able to :

- Develop an understanding of basic theory of these computational tools;
- Gain working knowledge of these computational tools and methods;
- Appreciate their relevance for investigating specific contemporary biological questions;
- Critically analyse and interpret results of their study.

Unit I **Bioinformatics basics** 5 lectures	Bioinformatics basics: Computers in biology and medicine; Introduction to Unix and Linux systems and basic commands; Database concepts; Protein and nucleic acid databases; Structural databases; Biological XML DTD's; pattern matching algorithm basics; databases and search tools: biological background for sequence analysis; Identification of protein sequence from DNA sequence; searching of databases similar sequence; NCBI; publicly available tools; resources at EBI; resources on web; database mining tools.
Unit II **DNA sequence analysis** 5 lectures	DNA sequence analysis: gene bank sequence database; submitting DNA sequences to databases and database searching; sequence alignment; pairwise alignment techniques; motif discovery and gene prediction; local structural variants of DNA, their relevance in molecular level processes, and their identification; assembly of data from genome sequencing.
Unit III **Multiple sequence analysis** 5 lectures	Multiple sequence analysis; multiple sequence alignment; flexible sequence similarity searching with the FASTA3 program package; use of CLUSTALW and CLUSTALX for multiple sequence alignment; submitting DNA protein sequence to databases: where and how to submit, SEQUIN, genome centres; submitting aligned sets of sequences, updating submitted sequences, methods of phylogenetic analysis.
Unit IV **Protein modelling** 5 lectures	Protein modelling: introduction; force field methods; energy, buried and exposed residues; side chains and neighbours; fixed regions; hydrogen bonds; mapping properties onto surfaces; fitting monomers; RMS fit of conformers; assigning secondary structures; sequence alignment- methods, evaluation, scoring; protein completion: backbone construction and side chain addition; small peptide methodology; software accessibility; building peptides; protein displays; substructure manipulations, annealing.
Unit V **Protein structure prediction and virtual library** 6 lectures	Protein structure prediction: protein folding and model generation; secondary structure prediction; analyzing secondary structures; protein loop searching; loop generating methods; homology modelling: potential applications, description, methodology, homologous sequence identification; align structures, align model sequence; construction of variable and conserved regions; threading techniques; topology fingerprint approach for prediction; evaluation of alternate models; structure prediction on a mystery sequence; structure aided sequence techniques of structure prediction; structural profiles, alignment algorithms, mutation tables, prediction, validation, sequence based methods of structure prediction, prediction using inverse folding, fold prediction; significance analysis, scoring techniques, sequence-sequence scoring; protein function prediction; elements of in silico drug design;Virtual library: Searching PubMed, current content, science citation index and current awareness services, electronic journals, grants and funding information.



Recommended Textbooks and References:

1. Lesk, A. M. (2002). *Introduction to Bioinformatics*. Oxford: Oxford University Press.
2. Mount, D. W. (2001). *Bioinformatics: Sequence and Genome Analysis*. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.
3. Baxevanis, A. D., & Ouellette, B. F. (2001). *Bioinformatics: a Practical Guide to the Analysis of Genes and Proteins*. New York: Wiley-Interscience.
4. Pevsner, J. (2015). *Bioinformatics and Functional Genomics*. Hoboken, NJ.: Wiley-Blackwell.
5. Bourne, P. E., & Gu, J. (2009). *Structural Bioinformatics*. Hoboken, NJ: Wiley-Liss.
6. Lesk, A. M. (2004). *Introduction to Protein Science: Architecture, Function, and Genomics*. Oxford: Oxford University Press.

Genomics and Proteomics

Credits

2

Course Objectives

The objectives of this course is to provide introductory knowledge concerning genomics, proteomics and their applications.

Student Learning Outcomes

Students should be able to acquire knowledge and understanding of fundamentals of genomics and proteomics, transcriptomics and metabolomics and their applications in various applied areas of biology.

Unit I **Basics of genomics and proteomics** 3 lectures	Brief overview of prokaryotic and eukaryotic genome organization; extra-chromosomal DNA: bacterial plasmids, mitochondria and chloroplast.
Unit II **Genome mapping** 4 lectures	Genetic and physical maps; markers for genetic mapping; methods and techniques used for gene mapping, physical mapping, linkage analysis, cytogenetic techniques, FISH technique in gene mapping, somatic cell hybridization, radiation hybrid maps, *in situ* hybridization, comparative gene mapping.
Unit III **Genome sequencing projects** 3 lectures	Human Genome Project, genome sequencing projects for microbes, plants and animals, accessing and retrieving genome project information from the web.
Unit IV **Comparative genomics** 5 lectures	Identification and classification of organisms using molecular markers- 16S rRNA typing/sequencing, SNPs; use of genomes to understand evolution of eukaryotes, track emerging diseases and design new drugs; determining gene location in genome sequence.
Unit V **Proteomics** 5 lectures	Aims, strategies and challenges in proteomics; proteomics technologies: 2D-PAGE, isoelectric focusing, mass spectrometry, MALDI-TOF, yeast 2-hybrid system, proteome databases.
Unit VI **Functional genomics and proteomics** 8 lectures	Transcriptome analysis for identification and functional annotation of gene, Contig assembly, chromosome walking and characterization of chromosomes, mining functional genes in genome, gene function- forward and reverse genetics, gene ethics; protein-protein and protein-DNA interactions; protein chips and functional proteomics; clinical and biomedical applications of proteomics; introduction to metabolomics, lipidomics, metagenomics and systems biology.

Recommended Textbooks and References:

1. Primrose, S. B., Twyman, R. M., Primrose, S. B., & Primrose, S. B. (2006). *Principles of Gene Manipulation and Genomics*. Malden, MA: Blackwell Pub.
2. Liebler, D. C. (2002). *Introduction to Proteomics: Tools for the New Biology*. Totowa, NJ: Humana Press.
3. Campbell, A. M., & Heyer, L. J. (2003). *Discovering Genomics, Proteomics, and Bioinformatics*. San Francisco: Benjamin Cummings.

Molecular Diagnostics

Credits

2

Course Objectives

The objectives of this course are to sensitize students about recent advances in molecular biology and various facets of molecular medicine which has potential to profoundly alter many aspects of modern medicine including pre- or post-natal analysis of genetic diseases and identification of individuals predisposed to disease ranging from common cold to cancer.

Student Learning Outcomes

Students should be able to understand various facets of molecular procedures and basics of genomics, proteomics and metabolomics that could be employed in early diagnosis and prognosis of human diseases.

Unit I **Genome biology in health and disease** 4 lectures	DNA, RNA, Protein: An overview; chromosomal structure & mutations; DNA polymorphism: human identity; clinical variability and genetically determined adverse reactions to drugs.
Unit II **Genome: resolution, detection & analysis** 5 lectures	PCR: Real-time; ARMS; Multiplex; ISH; FISH; ISA; RFLP; DHPLC; DGGE; CSCE; SSCP; Nucleic acid sequencing: new generations of automated sequencers; Microarray chips; EST; SAGE; microarray data normalization & analysis; molecular markers: 16S rRNA typing; Diagnostic proteomics: SELDI-TOF-MS; Bioinformatics data acquisition & analysis.
Unit III **Diagnostic metabolomics** 2 lectures	Metabolite profile for biomarker detection the body fluids/tissues in various metabolic disorders by making using LCMS & NMR technological platforms.
Unit IV **Detection and identity of microbial diseases** 4 lectures	Direct detection and identification of pathogenic-organisms that are slow growing or currently lacking a system of *in vitro* cultivation as well as genotypic markers of microbial resistance to specific antibiotics.
Unit V **Detection of inherited diseases** 4 lectures	Exemplified by two inherited diseases for which molecular diagnosis has provided a dramatic improvement of quality of medical care: Fragile X Syndrome: Paradigm of new mutational mechanism of unstable triplet repeats, von-Hippel Lindau disease: recent acquisition in growing number of familial cancer syndromes.
Unit VI **Molecular oncology** 5 lectures	Detection of recognized genetic aberrations in clinical samples from cancer patients; types of cancer-causing alterations revealed by next-generation sequencing of clinical isolates; predictive biomarkers for personalized onco-therapy of human diseases such as chronic myeloid leukemia, colon, breast, lung cancer and melanoma as well as matching targeted therapies with patients and preventing toxicity of standard systemic therapies.
Unit VII **Quality assurance and control** 1 lecture	Quality oversight; regulations and approved testing.

Recommended Textbooks and References:

1. Campbell, A. M., & Heyer, L. J. (2006). *Discovering Genomics, Proteomics, and Bioinformatics*. San Francisco: Benjamin Cummings.
2. Brooker, R. J. (2009). *Genetics: Analysis & Principles*. New York, NY: McGraw-Hill.

3. Glick, B. R., Pasternak, J. J., & Patten, C. L. (2010). *Molecular Biotechnology: Principles and Applications of Recombinant DNA*. Washington, DC: ASM Press.
4. Coleman, W. B., & Tsongalis, G. J. (2010). *Molecular Diagnostics: for the Clinical Laboratorian*. Totowa, NJ: Humana Press.

Research Methodology and Scientific Communication Skills

Credits

2

Course Objectives

The objectives of this course are to give background on history of science, emphasizing methodologies used to do research, use framework of these methodologies for understanding effective lab practices and scientific communication and appreciate scientific ethics.

Student Learning Outcomes

Students should be able to:

- Understand history and methodologies of scientific research, applying these to recent published papers;
- Understand and practice scientific reading, writing and presentations;
- Appreciate scientific ethics through case studies.

Unit I **History of science and science methodologies** 8 lectures	Empirical science; scientific method; manipulative experiments and controls; deductive and inductive reasoning; descriptive science; reductionist *vs* holistic biology.
Unit II **Preparation for research** 2 lectures	Choosing a mentor, lab and research question; maintaining a lab notebook.
Unit III **Process of communication** 5 lectures	Concept of effective communication- setting clear goals for communication; determining outcomes and results; initiating communication; avoiding breakdowns while communicating; creating value in conversation; barriers to effective communication; non-verbal communication-interpreting non-verbal cues; importance of body language, power of effective listening; recognizing cultural differences; Presentation skills - formal presentation skills; preparing and presenting using over-head projector, PowerPoint; defending interrogation; scientific poster preparation & presentation; participating in group discussions; Computing skills for scientific research - web browsing for information search; search engines and their mechanism of searching; hidden Web and its importance in scientific research; internet as a medium of interaction between scientists; effective email strategy using the right tone and conciseness.
Unit IV **Scientific communication** 9 lectures	Technical writing skills - types of reports; layout of a formal report; scientific writing skills - importance of communicating science; problems while writing a scientific document; plagiarism, software for plagiarism; scientific publication writing: elements of a scientific paper including abstract, introduction, materials & methods, results, discussion, references; drafting titles and framing abstracts; publishing scientific papers - peer review process and problems, recent developments such as open access and non-blind review; plagiarism; characteristics of effective technical communication; scientific presentations; ethical issues; scientific misconduct.

Recommended Textbooks and References:

1. Valiela, I. (2001). *Doing Science: Design, Analysis, and Communication of Scientific Research.* Oxford: Oxford University Press.
2. *On Being a Scientist: a Guide to Responsible Conduct in Research.* (2009). Washington, D.C.: National Academies Press.
3. Gopen, G. D., & Smith, J. A. *The Science of Scientific Writing.* American Scientist, 78 (Nov-Dec 1990), 550-558.
4. Mohan, K., & Singh, N. P. (2010). *Speaking English Effectively.* Delhi: Macmillan India.
5. Movie: Naturally Obsessed, The Making of a Scientist.

Laboratory IV: Molecular Biology and Genetic Engineering

Credits



Course Objectives

The objectives of this course are to provide students with experimental knowledge of molecular biology and genetic engineering.

Student Learning Outcomes

Students should be able to gain hands-on experience in gene cloning, protein expression and purification. This experience would enable them to begin a career in industry that engages in genetic engineering as well as in research laboratories conducting fundamental research.

Syllabus

1. Concept of lac-operon:
   a) Lactose induction of B-galactosidase.
   b) Glucose Repression
   c) Diauxic growth curve of *E.coli*
2. UV mutagenesis to isolate amino acid auxotroph
3. Phage titre with epsilon phage/M13
4. Genetic Transfer-Conjugation, gene mapping
5. Plasmid DNA isolation and DNA quantitation
6. Restriction Enzyme digestion of plasmid DNA
7. Agarose gel electrophoresis
8. Polymerase Chain Reaction and analysis by agarose gel electrophoresis
9. Vector and Insert Ligation
10. Preparation of competent cells
11. Transformation of *E.coli* with standard plasmids, Calculation of transformation efficiency
12. Confirmation of the insert by Colony PCR and Restriction mapping
13. Expression of recombinant protein, concept of soluble proteins and inclusion body formation in *E.coli*, SDS-PAGE analysis
14. Purification of His-Tagged protein on Ni-NTA columns
    a) Random Primer labeling
    b) Southern hybridization.

Recommended Textbooks and References:

1. Green, M. R., & Sambrook, J. (2012). *Molecular Cloning: a Laboratory Manual.* Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.

Laboratory V: Immunology

Credits



Course Objectives

The objectives of this laboratory course are to develop an understanding about practical aspects of components of immune system as well as their function. Basic as well as advanced methods will be taught to detect different antigen and antibody interactions, isolation of different lymphocyte cells *etc.* and how they can be used in respective research work.

Student Learning Outcomes

Students should be able to:

- Evaluate usefulness of immunology in different pharmaceutical companies;
- Identify proper research lab working in area of their own interests;
- Apply their knowledge and design immunological experiments to demonstrate innate, humoral or cytotoxic T lymphocyte responses and figure out kind of immune responses in setting of infection (viral or bacterial) by looking at cytokine profile.

Syllabus

1. Selection of animals, preparation of antigens, immunization and methods of blood collection, serum separation and storage.
2. Antibody titre by ELISA method.
3. Double diffusion, Immuno-electrophoresis and Radial Immuno diffusion.
4. Complement fixation test.
5. Isolation and purification of IgG from serum or IgY from chicken egg.
6. SDS-PAGE, Immunoblotting, Dot blot assays.
7. Blood smear identification of leucocytes by Giemsa stain.
8. Separation of leucocytes by dextran method.
9. Demonstration of Phagocytosis of latex beads and their cryopreservation.
10. Separation of mononuclear cells by Ficoll-Hypaque and their cryopreservation.
11. Demonstration of ELISPOT.
12. Demonstration of FACS.

Semester Three

Bioprocess Engineering & Technology

Credits



Course Objectives

The objectives of this course are to educate students about the fundamental concepts of bioprocess technology and its related applications, thus preparing them to meet the challenges of the new and emerging areas of biotechnology industry.

Student Learning Outcomes

Students should be able to:

- Appreciate relevance of microorganisms from industrial context;
- Carry out stoichiometric calculations and specify models of their growth;
- Give an account of design and operations of various fermenters;
- Present unit operations together with the fundamental principles for basic methods in production technique for bio-based products;
- Calculate yield and production rates in a biological production process, and also interpret data;
- Calculate the need for oxygen and oxygen transfer;
- Critically analyze any bioprocess from market point of view;
- Give an account of important microbial/enzymatic industrial processes in food and fuel industry.

Unit I **Basic principles of biochemical engineering** 4 lectures	Isolation, screening and maintenance of industrially important microbes; microbial growth and death kinetics (an example from each group, particularly with reference to industrially useful microorganisms); strain improvement for increased yield and other desirable characteristics.
Unit II **Stoichiometry and models of microbial growth** 4 lectures	Elemental balance equations; metabolic coupling – ATP and NAD+; yield coefficients; unstructured models of microbial growth; structured models of microbial growth.
Unit III **Bioreactor design and analysis** 8 lectures	Batch and continuous fermenters; modifying batch and continuous reactors: chemostat with recycle, multistage chemostat systems, fed-batch operations; conventional fermentation v/s biotransformation; immobilized cell systems; large scale animal and plant cell cultivation; fermentation economics; upstream processing: media formulation and optimization; sterilization; aeration, agitation and heat transfer in bioprocess; scale up and scale down; measurement and control of bioprocess parameters.
Unit IV **Downstream processing and product recovery** 8 lectures	Separation of insoluble products - filtration, centrifugation, sedimentation, flocculation; Cell disruption; separation of soluble products: liquid-liquid extraction, precipitation, chromatographic techniques, reverse osmosis, ultra and micro filtration, electrophoresis; final purification: drying; crystallization; storage and packaging.
Unit V **Fermentation economics** 4 lectures	Isolation of micro-organisms of potential industrial interest; strain improvement; market analysis; equipment and plant costs; media; sterilization, heating and cooling; aeration and agitation; bath-process cycle times and continuous cultures; recovery costs; water usage and recycling; effluent treatment and disposal.
Unit VI **Applications of enzyme technology in food processing** 4 lectures	Mechanism of enzyme function and reactions in process techniques; enzymatic bioconversions *e.g.* starch and sugar conversion processes; high-fructose corn syrup; interesterified fat; hydrolyzed protein *etc.* and their downstream processing; baking by amylases, deoxygenation and desugaring by glucoses oxidase, beer mashing and chill proofing; cheese making by proteases and various other enzyme catalytic actions in food processing.
Unit VII **Applications of microbial technology in food process operations and production, biofuels and biorefinery** 4 lectures	Fermented foods and beverages; food ingredients and additives prepared by fermentation and their purification; fermentation as a method of preparing and preserving foods; microbes and their use in pickling, producing colours and flavours, alcoholic beverages and other products; process wastes-whey, molasses, starch substrates and other food wastes for bioconversion to useful products; bacteriocins from lactic acid bacteria – production and applications in food preservation; biofuels and biorefinery

Recommended Textbooks and References:

1. Shuler, M. L., & Kargi, F. (2002). *Bioprocess Engineering: Basic Concepts.* Upper Saddle River, NJ: Prentice Hall.
2. Stanbury, P. F., & Whitaker, A. (2010). *Principles of Fermentation Technology.* Oxford: Pergamon Press.
3. Blanch, H. W., & Clark, D. S. (1997). *Biochemical Engineering.* New York: M. Dekker.
4. Bailey, J. E., & Ollis, D. F. (1986). *Biochemical Engineering Fundamentals.* New York: McGraw-Hill.

5. El-Mansi, M., & Bryce, C. F. (2007). *Fermentation Microbiology and Biotechnology.* Boca Raton: CRC/Taylor & Francis.

Emerging Technologies

Credits

2

Course Objectives

This course is broad-based in nature encompassing several new technologies that current experimental researchers are employing to probe complex system biology questions in life-sciences. The objectives of this course are to teach basics of the new principles to students so as to appreciate current-day research tool-kit better.

Student Learning Outcomes

Students should be to learn history, theoretical basis and basic understanding of latest technologies in area of biotechnology. They should also be able to learn about various applications of these technologies. The students may also learn one application in depth through an assignment and/or seminar.

Unit I
Optical microscopy methods
8 lectures

Basic Microscopy: Light Microscopy: lenses and microscopes, resolution: Rayleigh's Approach, Darkfield; Phase Contrast; Differential Interference Contrast; fluorescence and fluorescence microscopy: what is fluorescence, what makes a molecule fluorescent, fluorescence microscope; optical arrangement, light source; filter sets: excitation filter, dichroic mirror, and barrier, optical layout for image capture; CCD cameras; back illumination, binning; recording color; three CCD elements with dichroic beamsplitters, boosting the signal.
Advanced Microscopy: Confocal microscope: scanning optical microscope, confocal principle, resolution and point spread function, light source: gas lasers & solid-state, primary beamsplitter; beam scanning, pinhole and signal channel configurations, detectors; pixels and voxels; contrast, spatial sampling: temporal sampling: signal-to-noise ratio, multichannel images. nonlinear microscopy: multiphoton microscopy; principles of two-photon fluorescence, advantages of two-photon excitation, tandem scanning (spinning disk) microscopes, deconvolving confocal images; image processing, three-dimensional reconstruction; advanced fluorescence techniques: FLIM, FRET, and FCS, Fluorescence Lifetime, Fluorescence Resonant Energy Transfer (FRET), Fluorescence Correlation Spectroscopy (FCS), Evanescent Wave Microscopy; Near-Field and Evanescent Waves, Total Internal Reflection Microscopy; Near-Field Microscopy; Beyond the Diffraction Limit: Stimulated Emission Depletion (STED), Super-Resolution Summary, Super-Resolution Imaging with Stochastic Optical Reconstruction Microscopy (STORM) and Photoactivated Localization Microscopy (PALM).

Unit II
Mass spectroscopy
4 lectures

Ionization techniques; mass analyzers/overview MS; FT-ICR and Orbitrap, fragmentation of peptides; proteomics, nano LC-MS; Phospho proteomics; interaction proteomics, mass spectroscopy in structural biology; imaging mass spectrometry.

Unit III
Systems biology
3 lectures

High throughput screens in cellular systems, target identification, validation of experimental methods to generate the omics data, bioinformatics analyses, mathematical modeling and designing testable predictions.

Unit IV
Structural biology
3 lectures

X-ray diffraction methods, solution & solid-state NMR, cryo-electron microscopy, small-angle X-ray scattering, Atomic force microscopy.

Unit V
CRISPR-CAS
6 lectures

History of its discovery, elucidation of the mechanism including introduction to all the molecular players, development of applications for *in vivo* genome engineering for genetic studies, promise of the technology as a next generation therapeutic method.

Unit VI
Nanobodies
4 lectures

Introduction to nanobodies, combining nanobody with phage-display method for development of antibody against native proteins, nanobody as a tool for protein structure-function studies, use of nanobodies for molecular imaging, catabolic antibodies using nanobodies.

Recommended Textbooks and References:

1. Campbell, I. D. (2012). *Biophysical Techniques*. Oxford: Oxford University Press.
2. Serdyuk, I. N., Zaccai, N. R., & Zaccai, G. (2007). *Methods in Molecular Biophysics: Structure, Dynamics, Function*. Cambridge: Cambridge University Press.
3. Phillips, R., Kondev, J., & Theriot, J. (2009). *Physical Biology of the Cell*. New York: Garland Science.
4. Nelson, P. C., Radosavljević, M., & Bromberg, S. (2004). *Biological Physics: Energy, Information, Life*. New York: W.H. Freeman.
5. Huang, B., Bates, M., & Zhuang, X. (2009). *Super-Resolution Fluorescence Microscopy*. Annual Review of Biochemistry, 78(1), 993-1016. doi:10.1146/annurev.biochem.77.061906.092014.
6. Mohanraju, P., Makarova, K. S., Zetsche, B., Zhang, F., Koonin, E. V., & Oost, J. V. (2016). *Diverse Evolutionary Roots and Mechanistic Variations of the CRISPR-Cas Systems*. Science, 353(6299). doi:10.1126/science.aad5147.
7. Lander, E. (2016). *The Heroes of CRISPR*. Cell, 164(1-2), 18-28. doi:10.1016/j.cell.2015.12.041.
8. Ledford, H. (2016). *The Unsung Heroes of CRISPR*. Nature, 535(7612), 342-344 doi:10.1038/535342a.
9. Jinek, M., Chylinski, K., Fonfara, I., Hauer, M., Doudna, J. A., & Charpentier, E. (2012). *A Programmable Dual-RNA-Guided DNA Endonuclease in Adaptive Bacterial Immunity*. Science, 337(6096), 816-821. doi:10.1126/science.1225829.
10. Hamers-Casterman, C., Atarhouch, T., Muyldermans, S., Robinson, G., Hammers, C., Songa, E. B., Hammers, R. (1993). *Naturally Occurring Antibodies Devoid of Light Chains*. Nature, 363(6428), 446-448. doi:10.1038/363446a0.
11. Sidhu, S. S., & Koide, S. (2007). *Phage Display for Engineering and Analyzing Protein Interaction Interfaces*. Current Opinion in Structural Biology, 17(4), 481-487. doi:10.1016/j.sbi.2007.08.007.
12. Steyaert, J., & Kobilka, B. K. (2011). *Nanobody Stabilization of G Protein-Coupled Receptor Conformational States*. Current Opinion in Structural Biology, 21(4), 567-572. doi:10.1016/j.sbi.2011.06.011.
13. Vincke, C., & Muyldermans, S. (2012). *Introduction to Heavy Chain Antibodies and Derived Nanobodies*. Single Domain Antibodies, 15-26. doi:10.1007/978-1-61779-968-6_2.
14. Verheesen, P., & Laeremans, T. (2012). *Selection by Phage Display of Single Domain Antibodies Specific to Antigens in their Native Conformation*. Single Domain Antibodies, 81-104. doi:10.1007/978-1-61779-968-6_6.
15. Li, J., Xia, L., Su, Y., Liu, H., Xia, X., Lu, Q. Reheman, K. (2012). *Molecular Imprint of Enzyme Active Site by Camel Nanobodies*. Journal of Biological Chemistry J. Biol. Chem., 287(17), 13713-13721. doi:10.1074/jbc.m111.336370.
16. Sohier, J., Laurent, C., Chevigné, A., Pardon, E., Srinivasan, V., Wernery, U. Galleni, M. (2013). *Allosteric Inhibition of VIM Metallo-β-Lactamases by a Camelid Nanobody*. Biochemical Journal, 450(3), 477-486. doi:10.1042/bj20121305.
17. Chakravarty, R., Goel, S., & Cai, W. (2014). *Nanobody: The "Magic Bullet" for Molecular Imaging?* Theranostics, 4(4), 386-398. doi:10.7150/thno.8006.

Critical Analysis of Classical Papers

Credits

2

Course Objectives

The objectives of this course are to familiarize students with classic literature to make them appreciate how ground-breaking discoveries were made without, necessarily, use of high-end technologies.

Student Learning Outcomes

Students should be able to train in the exercise of hypothesis building and methods of addressing the hypothesis with readily available technology.

How does the Course Module work? Students may be divided in groups and each group may be responsible for one classical paper. Each week there may be a 1.5 hour presentation cum discussion for each of the papers. At the end of the semester each student will be asked to write a mini-review (2-3 pages long) on any one classical paper, other than the one he/she presented/discussed.

A list of sixteen classic papers and some suggested reference materials:

Syllabus

Molecular Biology

1. Studies on the chemical nature of the substance inducing transformation of Pneumococcal types: Induction of transformation by a desoxyribonucleic acid fraction isolated from *Pneumococcus* type III.
   Avery OT, Macleod CM, McCarty M.; J Exp Med. 1944 Feb 1;79(2):137-58.
   Note: This paper demonstrates that DNA is the transforming Principle originally described by Fredrick Griffith.
2. Independent functions of viral protein and nucleic acid in growth of bacteriophage
   Hershey AD and Chase M.; J Gen Physiol. 1952 May;36(1):39-56.
   Note: Note: This paper demonstrates that DNA, and not protein, component of phages enter bacterial cells.
3. Molecular structure of nucleic acids; a structure for deoxyribose nucleic acid
   Watson JD and Crick FH; Nature. 1953 Apr 25;171(4356):737-8
   Note: In this one page paper Watson and Crick first described the structure of DNA double helix
   Study help - Watson_Crick_Nature_1953_annotated
4. Transposable mating type genes in *Saccharomyces cerevisiae*
   James Hicks, Jeffrey N. Strathern & Amar J.S. Klar; Nature 282, 478-483,1979
   Note: This paper provided evidence for 'cassette hypothesis' of yeast mating type switches *i.e.* interconversion of mating types in yeast *(S. cerevisiae)* occurs by DNA rearrangement.
5. Messelson & Stahl experiment demonstrating semi-conservative replication of DNA.
   Meselson M and Stahl FW.; Proc Natl Acad Sci U S A. 1958 Jul 15;44(7):671-82
   Note: The experiment demonstrating semi-conservative mode of DNA replication is referred to as "the most beautiful experiment in biology"
6. *In vivo* alteration of telomere sequences and senescence caused by mutated *Tetrahymena* telomerase RNAs
   Guo-Liang Yu, John D. Bradley, Laura D. Attardi & Elizabeth H. Blackburn; Nature 344, 126-132, 1990
   Note: This paper demonstrates that the telomerase contains the template for telomere synthesis

Syllabus

Cell Biology

1. A protein-conducting channel in the endoplasmic reticulum
   Simon SM AND Blobel G.; Cell. 1991 May 3;65(3):371-80
   Note: This paper demonstrates the existence of a protein conducting channel
   Study help - A brief history of Signal Hypothesis

2. Identification of 23 complementation groups required for post-translational events in the yeast secretory pathway
   Novick P, Field C, Schekman R.; Cell. 1980 Aug;21(1):205-15
   Note: In this groundbreaking paper Randy Schekman's group used a mutagenesis screen for fast sedimenting yeast mutants to identify genes involved in cell secretion
3. A yeast mutant defective at an early stage in import of secretory protein precursors into the endoplasmic reticulum
   Deshaies RJ and Schekman R.; J Cell Biol. 1987 Aug;105(2):633-45
   Note: Using another yeast mutation screen Schekman lab identifies Sec61, a component of ER protein Conducting Channel (PCC)
   Suggested reference paper - A biochemical assay for identification of PCC.
4. Reconstitution of the Transport of Protein between Successive Compartments of the Golgi
   Balch WE, Dunphy WG, Braell WA, Rothman JE.; Cell. 1984 Dec;39(2 Pt 1):405-16
   Note: This paper describes setting up of an *in vitro* reconstituted system for transport between golgi stacks which eventually paved the way for identification of most of the molecular players involved in these steps including NSF, SNAP *etc.*
5. A complete immunoglobulin gene is created by somatic recombination
   Brack C, Hirama M, Lenhard-Schuller R, Tonegawa S.; Cell. 1978 Sep;15(1):1-14
   Note: This study demonstrates DNA level molecular details of somatic rearrangement of immunoglobulin gene sequences leading to the generation of functionally competent antibody generating gene following recombination.
6. A novel multigene family may encode odorant receptors: a molecular basis for odor recognition
   Buck L and Axel R; Cell. 1991 Apr 5;65(1):175-87
   Note: This paper suggests that different chemical odorants associate with different cell-specific expression of a transmembrane receptor in *Drosophila* olfactory epithelium where a large family of odorat receptors is expressed.
7. Kinesin walks hand-over-hand
   Yildiz A, Tomishige M, Vale RD, Selvin PR.; Science. 2004 Jan 30;303(5658):676-8
   Note: This paper shows that kinesin motor works as a two-headed dimeric motor walking hand-over-hand rather than like an inchworm on microtubule tract using the energy of ATP hydrolysis.

Syllabus
Developmental Biology/ Genetics

1. Mutations affecting segment number and polarity in *Drosophila*
   Christiane Nusslein-Volhard and Eric Weischaus; Nature 287, 795-801, 1980
   Note: This single mutagenesis screen identified majority of the developmentally important genes not only in flies but in other metazoans as well.
2. Information for the dorsal--ventral pattern of the *Drosophila* embryo is stored as maternal mRNA
   Anderson KV and Nüsslein-Volhard C; Nature. 1984 Sep 20-26;311(5983):223-7
   Note: This landmark paper demonstrated that early dorsal-ventral pattern information is stored as maternal mRNA in flies and devised the method of identifying genes encoding such genes
3. Hedgehog signalling in the mouse requires intraflagellar transport proteins
   Huangfu D, Liu A, Rakeman AS, Murcia NS, Niswander L, Anderson KV.; Nature. 2003 Nov 6;426(6962):83-7
   Note: One of the architects of original fly mutagenesis screens conducted a mouse mutagenes screen which identified a gene Kif3a as a major component of hedgehog signaling pathway. Eventually this discovery revolutionizes our understanding of mechanisms of action of signaling pathways by demonstrating central role of cillia in it.
   Suggested Reference paper - Design and execution of a embryonic lethal mutation screen in mouse.

Bioentrepreneurship

Credits

2

Course Objectives

Research and business belong together and both are needed. In a rapidly developing life science industry, there is an urgent need for people who combine business knowledge with the understanding of science & technology. Bio-entrepreneurship, an interdisciplinary course, revolves around the central theme of how to manage and develop life science companies and projects. The objectives of this course are to teach students about concepts of entrepreneurship including identifying a winning business opportunity, gathering funding and launching a business, growing and nurturing the organization and harvesting the rewards.

Student Learning Outcomes

Students should be able to gain entrepreneurial skills, understand the various operations involved in venture creation, identify scope for entrepreneurship in biosciences and utilize the schemes promoted through knowledge centres and various agencies. The knowledge pertaining to management should also help students to be able to build up a strong network within the industry.

Unit I

Innovation and entrepreneurship in bio-business

8 lectures

Introduction and scope in Bio-entrepreneurship, Types of bio-industries and competitive dynamics between the sub-industries of the bio-sector (*e.g.* pharmaceuticals *vs.* Industrial biotech), Strategy and operations of bio-sector firms: Factors shaping opportunities for innovation and entrepreneurship in bio-sectors, and the business implications of those opportunities, Alternatives faced by emerging bio-firms and the relevant tools for strategic decision, Entrepreneurship development programs of public and private agencies (MSME, DBT, BIRAC, Make In India), strategic dimensions of patenting & commercialization strategies.

Unit II

Bio markets - business strategy and marketing

8 lectures

Negotiating the road from lab to the market (strategies and processes of negotiation with financiers, government and regulatory authorities), Pricing strategy, Challenges in marketing in bio business (market conditions & segments; developing distribution channels, the nature, analysis and management of customer needs), Basic contract principles, different types of agreement and contract terms typically found in joint venture and development agreements, Dispute resolution skills.

Unit III

Finance and accounting

8 lectures

Business plan preparation including statutory and legal requirements, Business feasibility study, financial management issues of procurement of capital and management of costs, Collaborations & partnership, Information technology.

Unit IV

Technology management

8 lectures

Technology – assessment, development & upgradation, Managing technology transfer, Quality control & transfer of foreign technologies, Knowledge centers and Technology transfer agencies, Understanding of regulatory compliances and procedures (CDSCO, NBA, GCP, GLA, GMP).

Recommended Textbooks and References:

1. Adams, D. J., & Sparrow, J. C. (2008). *Enterprise for Life Scientists: Developing Innovation and Entrepreneurship in the Biosciences*. Bloxham: Scion.
2. Shimasaki, C. D. (2014). *Biotechnology Entrepreneurship: Starting, Managing, and Leading Biotech Companies*. Amsterdam: Elsevier. Academic Press is an imprint of Elsevier.

3. Onetti, A., & Zucchella, A. *Business Modeling for Life Science and Biotech Companies: Creating Value and Competitive Advantage with the Milestone Bridge.* Routledge.
4. Jordan, J. F. (2014). *Innovation, Commercialization, and Start-Ups in Life Sciences.* London: CRC Press.
5. Desai, V. (2009). *The Dynamics of Entrepreneurial Development and Management.* New Delhi: Himalaya Pub. House.

Intellectual Property Rights, Biosafety and Bioethics

Credits

2

Course Objectives

The objectives of this course are:

- To provide basic knowledge on intellectual property rights and their implications in biological research and product development;
- To become familiar with India's IPR Policy;
- To learn biosafety and risk assessment of products derived from biotechnology and regulation of such products;
- To become familiar with ethical issues in biological research. This course will focus on consequences of biomedical research technologies such as cloning of whole organisms, genetic modifications, DNA testing.

Student Learning Outcomes

On completion of this course, students should be able to:

- Understand the rationale for and against IPR and especially patents;
- Understand why India has adopted an IPR Policy and be familiar with broad outline of patent regulations;
- Understand different types of intellectual property rights in general and protection of products derived from biotechnology research and issues related to application and obtaining patents;
- Gain knowledge of biosafety and risk assessment of products derived from recombinant DNA research and environmental release of genetically modified organisms, national and international regulations;
- Understand ethical aspects related to biological, biomedical, health care and biotechnology research.

Unit I
Introduction to IPR
5 lectures

Introduction to intellectual property; types of IP: patents, trademarks, copyright & related rights, industrial design, traditional knowledge, geographical indications, protection of new GMOs; International framework for the protection of IP; IP as a factor in R&D; IPs of relevance to biotechnology and few case studies; introduction to history of GATT, WTO, WIPO and TRIPS; plant variety protection and farmers rights act; concept of 'prior art': invention in context of "prior art"; patent databases - country-wise patent searches (USPTO, EPO, India); analysis and report formation.

Unit II
Patenting
5 lectures

Basics of patents: types of patents; Indian Patent Act 1970; recent amendments; WIPO Treaties; Budapest Treaty; Patent Cooperation Treaty (PCT) and implications; procedure for filing a PCT application; role of a Country Patent Office; filing of a patent application; precautions before patenting-disclosure/non-disclosure - patent application- forms and guidelines including those of National Bio-diversity Authority (NBA) and other regulatory bodies, fee structure, time frames; types of patent applications: provisional and complete specifications; PCT and conventional patent applications; international patenting-requirement, procedures and costs; financial assistance for patenting-introduction to existing schemes; publication of patents-gazette of India, status in Europe and US; patent infringement- meaning, scope, litigation, case studies and examples; commercialization of patented innovations; licensing – outright sale, licensing, royalty; patenting by research students and scientists-university/organizational rules in India and abroad, collaborative research - backward and forward IP; benefit/credit sharing among parties/community, commercial (financial) and non-commercial incentives.

Unit III
Biosafety
5 lectures

Biosafety and Biosecurity - introduction; historical background; introduction to biological safety cabinets; primary containment for biohazards; biosafety levels; GRAS organisms, biosafety levels of specific microorganisms; recommended biosafety levels for infectious agents and infected animals; definition of GMOs & LMOs; principles of safety assessment of transgenic plants – sequential steps in risk assessment; concepts of familiarity and substantial equivalence; risk – environmental risk assessment and food and feed safety assessment; problem formulation – protection goals, compilation of relevant information, risk characterization and development of analysis plan; risk assessment of transgenic crops *vs* cisgenic plants or products derived from RNAi, genome editing tools.

Unit IV
National and international regulations
5 lectures

International regulations – Cartagena protocol, OECD consensus documents and Codex Alimentarius; Indian regulations – EPA act and rules, guidance documents, regulatory framework – RCGM, GEAC, IBSC and other regulatory bodies; Draft bill of Biotechnology Regulatory authority of India - containments – biosafety levels and category of rDNA experiments; field trails – biosafety research trials – standard operating procedures - guidelines of state governments; GM labeling – Food Safety and Standards Authority of India (FSSAI).

Unit V
Bioethics
5 lectures

Introduction, ethical conflicts in biological sciences - interference with nature, bioethics in health care - patient confidentiality, informed consent, euthanasia, artificial reproductive technologies, prenatal diagnosis, genetic screening, gene therapy, transplantation. Bioethics in research – cloning and stem cell research, Human and animal experimentation, animal rights/welfare, Agricultural biotechnology - Genetically engineered food, environmental risk, labeling and public opinion. Sharing benefits and protecting future generations - Protection of environment and biodiversity – biopiracy.



Recommended Textbooks and References:

1. Ganguli, P. (2001). *Intellectual Property Rights: Unleashing the Knowledge Economy.* New Delhi: Tata McGraw-Hill Pub.
2. *National IPR Policy*, Department of Industrial Policy & Promotion, Ministry of Commerce, GoI
3. *Complete Reference to Intellectual Property Rights Laws.* (2007). Snow White Publication Oct.
4. Kuhse, H. (2010). *Bioethics: an Anthology.* Malden, MA: Blackwell.
5. Office of the Controller General of Patents, Design & Trademarks; Department of Industrial Policy & Promotion; Ministry of Commerce & Industry; Government of India. http://www.ipindia.nic.in/
6. Karen F. Greif and Jon F. Merz, *Current Controversies in the Biological Sciences -Case Studies of Policy Challenges from New Technologies*, MIT Press
7. World Trade Organisation. http://www.wto.org
8. World Intellectual Property Organisation. http://www.wipo.int
9. International Union for the Protection of New Varieties of Plants. http://www.upov.int
10. National Portal of India. http://www.archive.india.gov.in
11. National Biodiversity Authority. http://www.nbaindia.org
12. Recombinant DNA Safety Guidelines, 1990 Department of Biotechnology, Ministry of Science and Technology, Govt. of India. Retrieved from http://www.envfor.nic.in/divisions/csurv/geac/annex-5.pdf
13. Wolt, J. D., Keese, P., Raybould, A., Fitzpatrick, J. W., Burachik, M., Gray, A., Wu, F. (2009). *Problem Formulation in the Environmental Risk Assessment for Genetically Modified Plants.* Transgenic Research, 19(3), 425-436. doi:10.1007/s11248-009-9321-9
14. Craig, W., Tepfer, M., Degrassi, G., & Ripandelli, D. (2008). *An Overview of General Features of Risk Assessments of Genetically Modified Crops.* Euphytica, 164(3), 853-880. doi:10.1007/s10681-007-9643-8

15. Guidelines for Safety Assessment of Foods Derived from Genetically Engineered Plants. 2008.
16. Guidelines and Standard Operating Procedures for Confined Field Trials of Regulated Genetically Engineered Plants. 2008. Retrieved from http://www.igmoris.nic.in/guidelines1.asp
17. Alonso, G. M. (2013). *Safety Assessment of Food and Feed Derived from GM Crops: Using Problem Formulation to Ensure "Fit for Purpose" Risk Assessments.* Retrieved from http://biosafety.icgeb.org/inhousepublicationscollectionbiosafetyreviews.

Project Proposal Preparation & Presentation

Credits

2

Course Objectives

The purpose of this course is to help students organize ideas, material and objectives for their dissertation and to begin development of communication skills and to prepare the students to present their topic of research and explain its importance to their fellow classmates and teachers.

Student Learning Outcomes

Students should be able to demonstrate the following abilities:

- Formulate a scientific question;
- Present scientific approach to solve the problem;
- Interpret, discuss and communicate scientific results in written form;
- Gain experience in writing a scientific proposal;
- Learn how to present and explain their research findings to the audience effectively.

Syllabus
Project Proposal Preparation

Selection of research lab and research topic: Students should first select a lab wherein they would like to pursue their dissertation. The supervisor or senior researchers should be able to help the students to read papers in the areas of interest of the lab and help them select a topic for their project. The topic of the research should be hypothesis driven.
Review of literature: Students should engage in systematic and critical review of appropriate and relevant information sources and appropriately apply qualitative and/or quantitative evaluation processes to original data; keeping in mind ethical standards of conduct in the collection and evaluation of data and other resources.
Writing Research Proposal: With the help of the senior researchers, students should be able to discuss the research questions, goals, approach, methodology, data collection, *etc.* Students should be able to construct a logical outline for the project including analysis steps and expected outcomes and prepare a complete proposal in scientific proposal format for dissertation.

Syllabus
Poster Presentation

Students will have to present the topic of their project proposal after few months of their selection of the topic. They should be able to explain the novelty and importance of their research topic.

Syllabus
Oral Presentation

At the end of their project, presentation will have to be given by the students to explain work done by them in detail. Along with summarizing their findings they should also be able to discuss the future expected outcome of their work.

Laboratory VI: Bioprocess Engineering & Technology

Credits



Course Objectives

The objectives of this laboratory course are to provide hands-on training to students in upstream and downstream unit operations.

Student Learning Outcomes

Students should be able to:

- Investigate, design and conduct experiments, analyze and interpret data, and apply the laboratory skills to solve complex bioprocess engineering problems;
- Apply skills and knowledge gained will be useful in solving problems typical of bio industries and research.

Syllabus

1. Basic Microbiology techniques
   a) Scale up from frozen vial to agar plate to shake flask culture.
   b) Instrumentation: Microplate reader, spectrophotometer, microscopy.
   c) Isolation of microorganisms from soil samples.
2. Experimental set-up
   a) Assembly of bioreactor and sterilization.
   b) Growth kinetics.
   c) Substrate and product inhibitions.
   d) Measurement of residual substrates.
3. Data Analysis
   a) Introduction to Metabolic Flux Analysis (MFA).
4. Fermentation
   a) Batch.
   b) Fed-batch.
   c) Continuous.
5. Unit operations
   a) Microfiltrations: Separation of cells from broth.
   b) Bioseparations: Various chromatographic techniques and extractions.
6. Bioanalytics
   a) Analytical techniques like HPLC, FPLC, GC, GC-MS *etc.* for measurement of amounts of products/substrates.



Recommended Textbooks and References:

1. Shuler, M. L., & Kargi, F. (2002). *Bioprocess Engineering: Basic Concepts*. Upper Saddle River, NJ: Prentice Hall.
2. Stanbury, P. F., & Whitaker, A. (2010). *Principles of Fermentation Technology*. Oxford: Pergamon Press.
3. Blanch, H. W., & Clark, D. S. (1997). *Biochemical Engineering*. New York: M. Dekker.
4. Bailey, J. E., & Ollis, D. F. (1986). *Biochemical Engineering Fundamentals*. New York: McGraw Hill.
5. El-Mansi, M., & Bryce, C. F. (2007). *Fermentation Microbiology and Biotechnology*. Boca Raton: CRC/Taylor & Francis.

Laboratory VII: Bioinformatics

Credits



Course Objectives

The aim of this course is to provide practical training in bioinformatic methods including accessing major public sequence databases, use of different computational tools to find sequences, analysis of protein and nucleic acid sequences by various software packages.

Student Learning Outcomes

On completion of this course, students should be able to:

- Describe contents and properties of most important bioinformatics databases;
- Perform text- and sequence-based searches and analyze and discuss results in light of molecular biological knowledge;
- Explain major steps in pairwise and multiple sequence alignment, explain principle and execute pairwise sequence alignment by dynamic programming;
- Predict secondary and tertiary structures of protein sequences.

Syllabus

1. Using NCBI and Uniprot web resources.
2. Introduction and use of various genome databases.
3. Sequence information resource: Using NCBI, EMBL, Genbank, Entrez, Swissprot/ TrEMBL, UniProt.
4. Similarity searches using tools like BLAST and interpretation of results.
5. Multiple sequence alignment using ClustalW.
6. Phylogenetic analysis of protein and nucleotide sequences.
7. Use of gene prediction methods (GRAIL, Genscan, Glimmer).
8. Using RNA structure prediction tools.
9. Use of various primer designing and restriction site prediction tools.
10. Use of different protein structure prediction databases (PDB, SCOP, CATH).
11. Construction and study of protein structures using Deepview/PyMol.
12. Homology modelling of proteins.
13. Use of tools for mutation and analysis of the energy minimization of protein structures.
14. Use of miRNA prediction, designing and target prediction tools.

Semester Four

Dissertation

Credits



(Semester III: 4 Credits; Semester IV: 20 Credits)

Course Objectives

The objectives of this course are to prepare the students to adapt to the research environment and understand how projects are executed in a research laboratory. It will also enable students to learn practical aspects of research and train students in the art of analysis and thesis writing.

Student Learning Outcomes

Students should be able to learn how to select and defend a topic of their research, how to effectively plan, execute, evaluate and discuss their experiments. Students should be able to demonstrate considerable improvement in the following areas:

- In-depth knowledge of the chosen area of research.
- Capability to critically and systematically integrate knowledge to identify issues that must be addressed within framework of specific thesis.
- Competence in research design

and planning.
- Capability to create, analyse and critically evaluate different technical solutions.
- Ability to conduct research independently.
- Ability to perform analytical techniques/experimental methods.
- Project management skills.
- Report writing skills.
- Problem solving skills.
- Communication and interpersonal skills.

Syllabus
Planning & performing experiments

Based on the project proposal submitted in earlier semester, students should be able to plan, and engage in, an independent and sustained critical investigation and evaluate a chosen research topic relevant to biological sciences and society. They should be able to systematically identify relevant theory and concepts, relate these to appropriate methodologies and evidence, apply appropriate techniques and draw appropriate conclusions. Senior researchers should be able to train the students such that they can work independently and are able to understand the aim of each experiment performed by them. They should also be able to understand the possible outcomes of each experiment.

Syllabus
Thesis writing

At the end of their project, thesis has to be written giving all the details such as aim, methodology, results, discussion and future work related to their project. Students may aim to get their research findings published in a peer-reviewed journal. If the research findings have application-oriented outcomes, the students may file patent application.

Recommended Electives

Biological Imaging

Credits

2

Course Objectives

The objectives of this course are to provide complete overview of state-of-art live-cell imaging techniques using microscopes currently available in literature. Live-cell imaging techniques allow real-time examination of almost every aspect of cellular function under normal and experimental conditions. With live-cell imaging experiments, main challenges are to keep cells alive and healthy over a period of time. The growing number of live-cell imaging techniques means one can obtain greater amounts of information without stressing out cells.

Student Learning Outcomes

On completion of this course, students shall be able to gain a complete overview of super-resolution field from fundamentals to state-of-art methods and applications in biomedical research. The students shall learn the comparative advantages and disadvantages of each technique, covers all key techniques in field of biomedical science. The students shall also learn how to use new tools to increase resolution in sub-nanometer-scale images of living cells and tissue, which leads to new information about molecules, pathways and dynamics and state-of-the-art examples of applications using microscopes.

Unit I
Widefield fluorescent microscopy
3 lectures

One of the most basic techniques for live-cell imaging is widefield fluorescent microscopy. Standard inverted research grade microscopes can yield valuable results if you are imaging adherent cells, large regions of interest (such as organelles) or very thin tissue sections (less than 5 micrometer). In widefield, a CCD camera is usually used to

	capture images and the epi-fluorescence illumination source can be a mercury lamp, xenon lamp, LED's, *etc.* Each of light sources require carefully matched interference filters for specific excitation and emission wavelengths of your fluorophore of interest. With widefield microscopy, your specimen is only exposed to excitation light for relatively short time periods as the full aperture of emission light is collected by the objectives. Widefield fluorescence microscopy can be used in combination with other common contrast techniques such as phase contrast and differential interference contract (DIC) microscopy. This combination is useful when performing live-cell imaging to examine general cell morphology or viability while also imaging regions of interest within cells.
Unit II **Confocal laser scanning microscopy (CLSM)** 3 lectures	CLSM has ability to eliminate out-of-focus light and information. It is also possible to obtain optical serial sections from thicker specimens. A conjugate pinhole in optical path of confocal microscope prevents fluorescence from outside of focal plane from being collected by photomultiplier detector or imaged by camera. In CLSM, a single pinhole (and single focused laser spot) is scanned across specimen by scanning system. This spot forms a reflected epi-fluorescence image back on original pinhole. When specimen is in focus, fluorescent light from it passes through pinhole to detector. Any out-of-focus light is defocused at pinhole and very little of this signal passes through to detector meaning that background fluorescence is greatly reduced. The pinhole acts as a spatial filter for emission light from the specimen.
Unit III **Spinning disc confocal microscopy (SDCM)** 2 lectures	This method utilises a 'Nipkow Disc' which is a mechanical opaque disc which has a series of thousands of drilled or etched pinholes arranged in a spiral pattern. Each illuminated pinhole on disc is imaged by microscope objective to a diffraction-limited spot on region of interest on specimen. The emission from fluorophores passes back though Nipkow disc pinholes and can be observed and captured by a CCD camera. The effect of spinning disc is that many thousands of points on specimen are simultaneously illuminated. Using SDCM to examine a specimen means that real-time imaging (30-frames-per-second or faster) can be achieved, which is extremely useful if you are looking at dynamic changes within living cells over a wide spectrum of time-scales.
Unit IV **Light-sheet fluorescence microscopy (LSFM, or SPIM)** 2 lectures	This method enables one to perform live-cell imaging on whole embryos, tissues and cell spheroids *in vivo* in a gentle manner with high temporal resolution and in three dimensions. One is able to track cell movement over extended periods of time and follow development of organs and tissues on a cellular level. The next evolution of light-sheet fluorescence microscopy, termed lattice light-sheet microscopy as developed by Eric Betzig (Nobel Prize Laureate 2014 for PALM super-resolution microscopy) will even allow live-cell imaging with super-resolved *in vivo* cellular localization capabilities.
Unit V **Super-resolved fluorescence microscopy** 8 lectures	Super-Resolution in a Standard Microscope: From Fast Fluorescence Imaging to Molecular Diffusion Laws in Live Cells; Photoswitching Fluorophores in Super-Resolution Fluorescence Microscopy; Image Analysis for Single-Molecule Localization Microscopy Deconvolution of Nanoscopic Images; Super-Resolution Fluorescence Microscopy of the Nanoscale Organization in cells; Correlative Live-Cell and Super-Resolution Microscopy and Its Biological Applications; SAX Microscopy and Its Application to Imaging of 3D-Cultured Cells; Quantitative Super-Resolution Microscopy for Cancer Biology and Medicine.
Unit VI **Re-scan confocal microscopy** 4 lectures	Structured Illumination Microscopy; Correlative Nanoscopy: AFM Super-Resolution (STED/STORM) ; Stochastic Optical Fluctuation Imaging.

Recommended Textbooks and References:

1. Rajagopal Vadivambal, Digvir S. Jayas. (2015). *Bio-Imaging: Principles, Techniques, and Applications.* ISBN 9781466593671 - CAT# K20618.
2. Alberto Diaspro, Marc A. M. J. van Zandvoort. (2016). *Super-Resolution Imaging in Biomedicine.* ISBN 9781482244342 - CAT# K23483.
3. Taatjes, Douglas, Roth, Jürgen (Eds.). (2012). *Cell Imaging Techniques Methods and Protocols.* ISBN 978-1-62703-056-4.

Computational Biology

Credits

2

Course Objectives

The objective of this course is to provide students with theory and practical experience of essentials to aid for genomic, proteomic and metabolomics courses and drug design program.

Student Learning Outcomes

On completion of this course, the students are expected to:

- Develop an understanding of the basic theory of these computational tools;
- Develop required database extraction, integration, coding for computational tools and methods necessary for all Omics;
- Create hypothesis for investigating specific contemporary biological questions, provide help to experiment with or develop appropriate tools;
- Critically analyze and interpret results of their study with respect to whole systems.

Unit I

Introduction to computational biology basics and biological databases

4 lectures

Computers in biology and medicine; Overview of biological databases, nucleic acid & protein databases, primary, secondary, functional, composite, structural classification database, Sequence formats & storage, Access databases, Extract and create sub databases, limitations of existing databases.

Unit II

Pairwise and multiple sequence alignments

5 lectures

Local alignment, Global alignment, Scoring matrices - PAM, BLOSUM, Gaps and penalties, Dot plots. Dynamic programming approach: Needleman and Wunsch Algorithm, Smith and Waterman Algorithm, Hidden Markov Model: Viterbi Algorithm. Heuristic approach: BLAST, FASTA. Building Profiles, Profile based functional identification.

Unit III

Genome analysis

6 lectures

Polymorphisms in DNA sequence, Introduction to Next Generation Sequencing technologies, Whole Genome Assembly and challenges, Sequencing and analysis of large genomes, Gene prediction, Functional annotation, Comparative genomics, Probabilistic functional gene networks, Human genome project, Genomics and crop improvement. Study available GWAS, ENCODE, HUGO projects, extract and build sub databases; Visualization tools including Artemis and Vista for genome comparison; Functional genomics case studies.

Unit IV

Structure visualization

3 lectures

Retrieving and drawing structures, Macromolecule viewing platforms, Structure validation and correction, Structure optimization, Analysis of ligand-protein interactions; Tools such as PyMol or VMD.

Unit V
Molecular modelling
6 lectures

Significance and need, force field methods, energy, buried and exposed residues; side chains and neighbours; fixed regions; hydrogen bonds; mapping properties onto surfaces; RMS fit of conformers and protein chains, assigning secondary structures: sequence alignment: methods, evaluation, scoring; protein curation: backbone construction and side chain addition; different types of protein chain modelling: ab initio, homology, hybrid, loop; Template recognition and alignments; Modelling parameters and considerations; Model analysis and validation; Model optimization; Substructure manipulations, annealing, protein folding and model generation; loop generating methods; loop analysis; Analysis of active sites using different methods in studying protein–protein interactions.

Unit VI
Structure-based drug development
6 lectures

Molecular docking: Types and principles, Semi-flexible docking, Flexible docking; Ligand and protein preparation, Macromolecule and ligand optimization, Ligand conformations, Clustering, Analysis of docking results and validation with known information. Extra-precision docking platforms, Use of Small-molecule libraries, Natural compound libraries for virtual high throughput screenings.

Unit VII
Ligand-based drug development
6 lectures

Quantitative structure activity relationships; Introduction to chemical descriptors like 2D, 3D and Group-based; Radar plots and contribution plots and Activity predictions, Pharmacophore modeling, Pharmacophore-based screenings of compound library, analysis and experimental validation.

Recommended Textbooks and References:

1. Mount, D. W. (2001). *Bioinformatics: Sequence and Genome Analysis*. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.
2. Bourne, P. E., & Gu, J. (2009). *Structural Bioinformatics*. Hoboken, NJ: Wiley-Liss.
3. Lesk, A. M. (2004). *Introduction to Protein Science: Architecture, Function, and Genomics*. Oxford: Oxford University Press.
4. Campbell, M & Heyer, L. J. (2006), *Discovering Genomics, Proteomics and Bioinformatics*, Pearson Education.
5. Oprea, T. (2005). *Chemoinformatics in Drug Discovery*, Volume 23. Wiley Online Library.
6. Gasteiger, J. & Engel,T. (2003), *Chemoinformatics: a Textbook*, Wiley Online Library.

Drug Discovery and Development

Credits

2

Course Objectives

This course will give a broad overview of research and development carried out in industrial setup towards drug discovery.

Student Learning Outcomes

On completion of this course, students should be able to understand basics of R&D in drug discovery and should be able to apply knowledge gained in respective fields of pharmaceutical industry.

Unit I
Target identification and molecular modelling
7 lectures

Identification of target or drug leads associated with a particular disease by a number of different techniques including combinations of molecular modeling, combinatorial libraries and high-throughput screening (HTS); Conceptualizing the automation of the HTS process and the importance of bioinformatics and data processing in identification of lead compounds; Rational drug design, based on understanding the three-dimensional

	structures and physicochemical properties of drugs and receptors; Modelling drug/ receptor interactions with the emphasis on molecular mechanisms, molecular dynamics simulations and homology modelling; Conformational sampling, macromolecular folding, structural bioinformatics, receptor-based and ligand-based design and docking methods, in silico screening of libraries, semi-empirical and ab-initio methods, QSAR methods, molecular diversity, design of combinatorial libraries of drug-like molecules, macromolecular and chemical databases.
Unit II **Lead optimization** 5 lectures	Identification of relevant groups on a molecule that interact with a receptor and are responsible for biological activity; Understanding structure activity relationship; Structure modification to increase potency and therapeutic index; Concept of quantitative drug design using Quantitative structure–activity relationship models (QSAR models) based on the fact that the biological properties of a compound are a function of its physicochemical parameters such as solubility, lipophilicity, electronic effects, ionization, stereochemistry, *etc.*; Bioanalytical assay development in support of *in vitro* and *in vivo* studies (LC/MS/MS, GC/MS and ELISA).
Unit III **Preclinical development** 5 lectures	Principles of drug absorption, drug metabolism and distribution - intestinal absorption, metabolic stability, drug-drug interactions, plasma protein binding assays, metabolite profile studies, Principles of toxicology, Experimental design for preclinical and clinical PK/PD/TK studies, Selection of animal model; Regulatory guidelines for preclinical PK/ PD/TK studies; Scope of GLP, SOP for conduct of clinical & non clinical testing, control on animal house, report preparation and documentation Integration of non-clinical and preclinical data to aid design of clinical studies.
Unit IV **Drug manufacturing** 4 lectures	Requirements of GMP implementation, Documentation of GMP practices, CoA, Regulatory certification of GMP, Quality control and Quality assurance, concept and philosophy of TQM, ICH and ISO 9000; ICH guidelines for Manufacturing, Understanding Impurity Qualification Data, Stability Studies.
Unit V **Clinical trial design** 4 lectures	Objectives of Phase I, II, III and IV clinical studies, Clinical study design, enrollment, sites and documentation, Clinical safety studies: Adverse events and adverse drug reactions, Clinical PK, pharmacology, drug-drug interaction studies, Statistical analysis and documentation.
Unit VI **Fundamentals of regulatory affairs and bioethics** 4 lectures	Global Regulatory Affairs and different steps involved, Regulatory Objectives, Regulatory Agencies; FDA guidelines on IND and NDA submissions, Studies required for IND and NDA submissions for oncology, HIV, cardiovascular indications, On-label *vs.* off-label drug use GCP and Requirements of GCP Compliance, Ethical issues and Compliance to current ethical guidelines, Ethical Committees and their set up, Animal Ethical issues and compliance.

Recommended Textbooks and References:

1. Krogsgaard-Larsen *et al. Textbook of Drug Design and Discovery*. 4th Edition. CRC Press.
2. Kuhse, H. (2010). *Bioethics: an Anthology*. Malden, MA: Blackwell.
3. Nally, J. D. (2006) *GMP for Pharmaceuticals*. 6th edition. CRC Press
4. Brody, T. (2016) *Clinical Trials: Study Design, Endpoints and Biomarkers*, Drug Safety, and FDA and ICH Guidelines. Academic Press.

Environmental Biotechnology

Credits

2

Course Objectives

This course aims to introduce fundamentals of Environmental Biotechnology. The course will introduce major groups of microorganisms-tools in biotechnology and their most important environmental applications. The environmental applications of biotechnology will be presented in detail and will be supported by examples from the national and international literature.

Student Learning Outcomes

On completion of course, students will be able to understand use of basic microbiological, molecular and analytical methods, which are extensively used in environmental biotechnology.

Unit I **Introduction to environment** 6 lectures	Introduction to environment; pollution and its control; pollution indicators; waste management: domestic, industrial, solid and hazardous wastes; strain improvement; Biodiversity and its conservation; Role of microorganisms in geochemical cycles; microbial energy metabolism, microbial growth kinetics and elementary chemostat theory, relevant microbiological processes, microbial ecology.
Unit II **Bioremediation** 6 lectures	Bioremediation: Fundamentals, methods and strategies of application (biostimulation, bioaugmentation) – examples, bioremediation of metals (Cr, As, Se, Hg), radionuclides (U, Te), organic pollutants (PAHs, PCBs, Pesticides, TNT *etc.*), technological aspects of bioremediation (*in situ, ex situ*).
Unit III **Role of microorganisms in bioremediation** 6 lectures	Application of bacteria and fungi in bioremediation: White rot fungi *vs* specialized degrading bacteria: examples, uses and advantages *vs* disadvantages; Phytoremediation: Fundamentals and description of major methods of application (phytoaccumulation, phytovolatilization, rhizofiltration phytostabilization).
Unit IV **Biotechnology and agriculture** 11 lectures	Bioinsecticides: *Bacillus thuringiensis*, Baculoviruses, uses, genetic modifications and aspects of safety in their use; Biofungicides: Description of mode of actions and mechanisms (*e.g. Trichoderma, Pseudomonas fluorescens*); Biofertilizers: Symbiotic systems between plants – microorganisms (nitrogen fixing symbiosis, mycorrhiza fungi symbiosis), Plant growth promoting rhizobacteria (PGPR) – uses, practical aspects and problems in application.
Unit V **Biofuels** 11 lectures	Environmental Biotechnology and biofuels: biogas; bioethanol; biodiesel; biohydrogen; Description of the industrial processes involved, microorganisms and biotechnological interventions for optimization of production; Microbiologically enhanced oil recovery (MEOR); Bioleaching of metals; Production of bioplastics; Production of biosurfactants: bioemulsifiers; Paper production: use of xylanases and white rot fungi.

Recommended Textbooks and References:

1. G. M. Evans and J. C. Furlong (2003), *Environmental Biotechnology: Theory and Applications*, Wiley Publishers.
2. B. Ritmann and P. L. McCarty, (2000), *Environmental Biotechnology: Principle & Applications*, 2nd Ed., McGraw Hill Science.
3. Scragg A., (2005) *Environmental Biotechnology*. Pearson Education Limited.
4. J. S. Devinny, M. A. Deshusses and T. S. Webster, (1998), *Biofiltration for Air Pollution Control*, CRC Press.
5. H. J. Rehm and G. Reed, (2001), *Biotechnology – A Multi-volume Comprehensive Treatise*, Vol. 11, 2nd Ed., VCH Publishers Inc.

6. H. S. Peavy, D. R. Rowe and G. Tchobanoglous, (2013), *Environmental Engineering*, McGraw-Hill Inc.

Microbial Technology

Credits

2

Course Objectives

The objectives of this course are to introduce students to developments/ advances made in field of microbial technology for use in human welfare and solving problems of the society.

Student Learning Outcomes

On completion of this course, students would develop deeper understanding of the microbial technology and its applications.

Unit I **Introduction to microbial technology** 8 lectures	Microbial technology in human welfare; Isolation and screening of microbes important for industry – advances in methodology and its application; Advanced genome and epigenome editing tools (*e.g.*, engineered zinc finger proteins, TALEs/TALENs, and the CRISPR/Cas9 system as nucleases for genome editing, transcription factors for epigenome editing, and other emerging tools) for manipulation of useful microbes/ strains and their applications; Strain improvement to increase yield of selected molecules, *e.g.*, antibiotics, enzymes, biofuels.
Unit II **Environmental applications of microbial technology** 6 lectures	Environmental application of microbes; Ore leaching; Biodegradation - biomass recycle and removal; Bioremediation - toxic waste removal and soil remediation; Global Biogeochemical cycles; Environment sensing (sensor organisms/ biological sensors); International and National guidelines regarding use of genetically modified organisms in environment, food and pharmaceuticals.
Unit III **Pharmaceutical applications of microbial technology** 8 lectures	Recombinant protein and pharmaceuticals production in microbes – common bottlenecks and issues (technical/operational, commercial and ethical); Attributes required in industrial microbes (*Streptomyces* sp., Yeast) to be used as efficient cloning and expression hosts (biologicals production); Generating diversity and introduction of desirable properties in industrially important microbes (*Streptomyces*/Yeast); Microbial cell factories; Downstream processing approaches used in industrial production process (*Streptomyces* sp., Yeast).
Unit IV **Food applications of microbial technology** 7 lectures	Application of microbes and microbial processes in food and healthcare industries - food processing and food preservation, antibiotics and enzymes production, microbes in targeted delivery application – drugs and vaccines (bacterial and viral vectors); Non-recombinant ways of introducing desirable properties in Generally recognized as safe (GRAS) microbes to be used in food (*e.g.*, Yeast) - exploiting the existing natural diversity or the artificially introduced diversity through conventional acceptable techniques (mutagenesis, protoplast fusion, breeding, genome shuffling, directed evolution *etc.*).
Unit V **Advances in microbial technology** 8 lectures	Microbial genomics for discovery of novel enzymes, drugs/ antibiotics; Limits of microbial genomics with respect to use in human welfare; Metagenomics and metatranscriptomics – their potential, methods to study and applications/use (animal and plant health, environmental clean-up, global nutrient cycles & global sustainability, understanding evolution), Global metagenomics initiative - surveys/projects and outcome, metagenomic library construction and functional screening in suitable hosts – tools and techniques for discovery/identification of novel enzymes, drugs (*e.g.*, protease, antibiotic) *etc.*

Recommended Textbooks and References:

1. Lee, Y. K. (2013). *Microbial Biotechnology: Principles and Applications.* Hackensack, NJ: World Scientific.
2. Moo-Young, M. (2011). *Comprehensive Biotechnology.* Amsterdam: Elsevier.
3. Nelson, K. E. (2015). Encyclopedia of Metagenomics. *Genes, Genomes and Metagenomes: Basics, Methods, Databases and Tools.* Boston, MA: Springer US.
4. *The New Science of Metagenomics Revealing the Secrets of Our Microbial Planet.* (2007). Washington, D.C.: National Academies Press.
5. Journals: (a) Nature, (b) Nature Biotechnology, (c) Applied microbiology and biotechnology, (d) Trends in Biotechnology, (e) Trends in Microbiology, (f) Current opinion in Microbiology, (g) Biotechnology Advances, (h) Genome Research)
6. Websites: http://jgi.doe.gov/our-science/

Protein Engineering

Credits

2

Course Objectives

The aim of this course is to introduce methods and strategies commonly used in protein engineering.

Student Learning Outcomes

On completion of this course, students should be able to:

- Analyse structure and construction of proteins by computer-based methods;
- Describe structure and classification of proteins;
- Analyse purity and stability of proteins and explain how to store them in best way;
- Explain how proteins can be used for different industrial and academic purposes such as structure determination, organic synthesis and drug design.

Unit I
Introduction to protein engineering
5 lectures

Protein engineering – definition, applications; Features or characteristics of proteins that can be engineered (definition and methods of study) – affinity and specificity; Spectroscopic properties; Stability to changes in parameters as pH, temperature and amino acid sequence, aggregation propensities, *etc.* Protein engineering with unnatural amino acids and its applications.

Unit II
Stability of protein structure
5 lectures

Methods of measuring stability of a protein; Spectroscopic methods to study physicochemical properties of proteins: far-UV and near-UV CD; Fluorescence; UV absorbance; ORD; Hydrodynamic properties–viscosity, hydrogen-deuterium exchange; Brief introduction to NMR spectroscopy – emphasis on parameters that can be measured/obtained from NMR and their interpretation.

Unit III
Applications
5 lectures

Forces stabilizing proteins – Van der waals, electrostatic, hydrogen bonding and weakly polar interactions, hydrophobic effects; Entropy – enthalpy compensation; Experimental methods of protein engineering: directed evolution like gene site saturation mutagenesis; Module shuffling; Guided protein recombination, *etc.*, Optimization and high throughput screening methodologies like GigaMetrix, High throughput microplate screens *etc.*, Application to devices with bacteriorhodopsin as an example; Engineering antibody affinity by yeast surface display; Applications to vaccines, Peptidomimetics and its use in drug discovery.

Unit IV
Computational approaches
5 lectures

Computational approaches to protein engineering: sequence and 3D structure analysis, Data mining, Ramachandran map, Mechanism of stabilization of proteins from psychrophiles and thermophiles *vis-à-vis* those from mesophiles; Protein design, Directed evolution for protein engineering and its potential.

Unit V
Case studies
1 lecture

Case Studies.



Recommended Textbooks and References:

1. Edited by T E Creighton, (1997), *Protein Structure: a Practical Approach*, 2nd Edition, Oxford university press.
2. Cleland and Craik, (2006), *Protein Engineering, Principles and Practice*, Vol 7, Springer Netherlands.
3. Mueller and Arndt, *Protein Engineering Protocols*, 1st Edition, Humana Press.
4. Ed. Robertson DE, Noel JP, (2004), *Protein Engineering Methods in Enzymology*, 388, Elsevier Academic Press.
5. J Kyte; (2006), *Structure in Protein Chemistry*, 2nd Edition, Garland publishers.

Nano-biotechnology

Credits



Course Objectives

The course aims at providing a general and broad introduction to multi-disciplinary field of nanotechnology. It will familiarize students with the combination of the top-down approach of microelectronics and micromechanics with the bottom-up approach of chemistry/biochemistry; a development that is creating new and exciting cross-disciplinary research fields and technologies. The course will also give an insight into complete systems where nanotechnology can be used to improve our everyday life.

Student Learning Outcomes

On successful completion of this course, students should be able to describe basic science behind the properties of materials at nanometre scale, and the principles behind advanced experimental and computational techniques for studying nanomaterials.

Unit I
Introduction to nanobiotechnology
5 lectures

Introduction to Nanobiotechnology; Concepts, historical perspective; Different formats of nanomaterials and applications with example for specific cases; Cellular Nanostructures; Nanopores; Biomolecular motors; Bio-inspired Nanostructures, Synthesis and characterization of different nanomaterials.

Unit II
Nano – films
5 lectures

Thin films; Colloidal nanostructures; Self Assembly, Nanovesicles; Nanospheres; Nanocapsules and their characterisation.

Unit III
Nano – particles
5 lectures

Nanoparticles for drug delivery, concepts, optimization of nanoparticle properties for suitability of administration through various routes of delivery, advantages, strategies for cellular internalization and long circulation, strategies for enhanced permeation through various anatomical barriers.

Unit IV
Applications of nano – particles
5 lectures

Nanoparticles for diagnostics and imaging (theranostics); concepts of smart stimuli responsive nanoparticles, implications in cancer therapy, nanodevices for biosensor development.

Unit V **Nano – materials** 5 lectures	Nanomaterials for catalysis, development and characterization of nanobiocatalysts, application of nanoscaffolds in sythesis, applications of nanobiocatalysis in the production of drugs and drug intermediates.
Unit VI **Nano – toxicity** 5 lectures	Introduction to Safety of nanomaterials, Basics of nanotoxicity, Models and assays for Nanotoxicity assessment; Fate of nanomaterials in different stratas of environment; Ecotoxicity models and assays; Life Cycle Assessment, containment.

Recommended Textbooks and References:

1. GeroDecher, Joseph B. Schlenoff, (2003); *Multilayer Thin Films: Sequential Assembly of Nanocomposite Materials*, Wiley-VCH Verlag GmbH & Co. KGaA
2. David S. Goodsell, (2004); *Bionanotechnology: Lessons from Nature*; Wiley-Liss
3. Neelina H. Malsch (2005), *Biomedical Nanotechnology*, CRC Press
4. Greg T. Hermanson, (2013); *Bioconjugate Techniques*, (3rd Edition); Elsevier
5. Recent review papers in the area of Nanomedicine.

Vaccines

Credits

2

Course Objectives

This course will provide students with an overview of current developments in different areas of vaccines.

Student Learning Outcomes

By the end of this course, students should be able to:

- Understand fundamental concepts of human immune system and basic immunology;
- Differentiate and understand immune responses in relation to infection and vaccination;
- Understand requirement and designing of different types of vaccines;
- Understand importance of conventional and new emerging vaccine technologies.

Unit I **Fundamentals of immune system** 6 lectures	Overview of Immune system; Human Immune system: Effectors of immune system; Innate & Adaptive Immunity; Activation of the Innate Immunity; Adaptive Immunity; T and B cells in adaptive immunity; Immune response in infection; Correlates of protection.
Unit II **Immune response to infection** 9 lectures	Protective immune response in bacterial; viral and parasitic infections; Primary and Secondary immune responses during infection; Antigen presentation and Role of Antigen presenting cells: Dendritic cells in immune response; Innate immune response; Humoral (antibody mediated) responses; Cell mediated responses: role of CD4+ and CD8+ T cells; Memory responses: Memory and effector T and B cells, Generation and Maintenance of memory T and B cells.
Unit III **Immune response to vaccination** 8 lectures	Vaccination and immune response; Adjuvants in Vaccination; Modulation of immune responses: Induction of Th1 and Th2 responses by using appropriate adjuvants and antigen delivery systems - Microbial adjuvants, Liposomal and Microparticles as delivery systems; Chemokines and cytokines; Role of soluble mediators in vaccination; Oral immunization and Mucosal Immunity.
Unit IV **Vaccine types & design** 3 lectures	History of vaccines, Conventional vaccines; Bacterial vaccines; Viral Vaccines; Vaccines based on routes of administration: parenteral, oral, mucosal; Live attenuated and inactivated vaccine; Subunit Vaccines and Toxoids; Peptide Vaccine.

Unit V

Vaccine technologies

4 lectures

New Vaccine Technologies; Rationally designed Vaccines; DNA Vaccination; Mucosal vaccination; New approaches for vaccine delivery; Engineering virus vectors for vaccination; Vaccines for targeted delivery (Vaccine Delivery systems); Disease specific vaccine design: Tuberculosis Vaccine; Malaria Vaccine; HIV/AIDS vaccine; New emerging diseases and vaccine needs (Ebola, Zika).



Recommended Textbooks and References:

1. Janeway, C. A., Travers, P., Walport, M., & Shlomchik, M. J. (2005). *Immuno Biology: the Immune System in Health and Disease*. USA: Garland Science Pub.
2. Kindt, T. J., Osborne, B. A., Goldsby, R. A., & Kuby, J. (2013). *Kuby Immunology*. New York: W.H. Freeman.
3. Kaufmann, S. H. (2004). *Novel Vaccination Strategies*. Weinheim: Wiley-VCH.
4. Journal Articles (relevant issues) from: Annual Review of Immunology, Annual Review of Microbiology, Current Opinion in Immunology, Nature Immunology, Expert review of vaccines.

Switching Theory and Logic Design

COURSE CODE:

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

1. To make the students understand the concepts of digital circuits.
2. To design complex digital circuits based on the given requirement.
3. Understand the programming of digital circuits using VHDL.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Understand the basic concepts of digital circuits.	Familiarity
CO-2	Learn about different the basic principles used in the working of digital circuits.	Familiarity
CO-3	Understand various hazards encountered in designing these circuits.	Assessment
CO-4	Learn to write programs using VHDL.	Usage

Course Contents:

Unit	Contents	Lectures required
1	Introduction to Digital Circuits: Design of combinational circuits, Quine-McCluskey method, sequential machine fundamentals - the need, concept of memory, Flip flops, sequential machine operations, classifications. Switching Circuits. Logic families: TTL, nMOS, CMOS, dynamic CMOS. Logic design using ROMs, PLAs and FPGAs. Case studies	5
2	Design of Synchronous Sequential Circuits: Sequential circuits, Finite state model – Basic definition, capabilities and limitation of finite state machines, state equivalence & machine minimization, simplification of incompletely specified machines, Extraction of maximal compatibles, synthesis & analysis of synchronous sequential circuits.	8
3	Design of Asynchronous Sequential Circuits: Introduction to asynchronous circuits, timing diagram, state diagram & flow tables, types of asynchronous circuits, fundamental mode circuits, pulse mode circuits, state assignment in asynchronous sequential circuits, Synthesis and analysis, ASM charts: Representation of sequential circuits using ASM charts.	8

4	Hazards and Races: Introduction, gate delays, generation of spikes, production of static hazards in combinational networks, elimination of static hazards, design of hazard free combinational networks, hazard free asynchronous circuit design, dynamic hazards, essential hazards, Races and Cycles.	9
5	VHDL/Verilog HDL: Verilog as HDL, Levels of Design Description, Concurrency, Simulation and Synthesis, Functional Verification, System Tasks, Programming Language Interface (PLI), Module, Simulation and Synthesis Tools, Test Benches. Language constructs and conventions: Introduction, Keywords, Identifiers, White Space Characters, Comments, Numbers, Strings, Logic Values, Strengths, Data Types, Scalars and Vectors, Parameters, Memory, Operators, System Tasks, Exercises.	12
Total lectures		42

Suggested Text Book(s):

1. Switching and Finite Automata Theory, ZVI Kohavi, Third Edition, Cambridge University Press.
2. John M Yarbrough : Digital Logic Applications and Design, 2nd Edition, Thomson Education
3. W. I. Fletcher :An Engineering approach to Digital Design , PHI

Suggested Reference Book(s):

1. Digital Systems Design using VHDL – Charles H Roth, CENGAGE Learning.

Other useful resource(s):

1. NPTEL: https://nptel.ac.in/courses/106/105/106105185/
2. Coursera: https://www.coursera.org/learn/digital-systems
3. Swayam: https://swayam.gov.in/nd1_noc19_cs74/preview

Evaluation Scheme:

S. No.	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes(2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Switching Theory and Logic Design)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	2	2	2	2	2	x	x	x	1	3	3	2.22
CO-2	3	3	3	2	2	3	x	x	x	1	2	3	2.44
CO-3	3	3	2	3	3	2	x	x	x	1	2	3	2.44
CO-4	3	3	2	3	3	2	x	x	x	1	3	2	2.44
Average	3	2.75	2.25	2.5	2.5	2.25	x	x	x	1	2.5	2.75	

Embedded System Design

COURSE CODE:

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

To learn about the embedded system application areas, design challenges, design and development methodology, tools used for embedded system design, embedded system integration and testing.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Understand various components of embedded system, design challenges and design metrics	Familiarity
CO-2	Learn about embedded system programming through 8051 microcontroller, programming and I/O interfacing	Usage
CO-3	Comprehend RISC architecture, programming of ARM and PIC microcontrollers	Usage
CO-4	Know about embedded system design and development methodology, tools and languages used for embedded system design	Usage
CO-5	Learn about integration and testing of embedded systems	Assessment

Course Contents:

Unit	Contents	Lectures Required
1	Introduction: Embedded systems overview, Classification, Application areas, Design challenges – real-time execution, physical size, power consumption, multirate operation. Design metrics – time-to-market, unit cost, performance.	4
2	Typical Embedded System: Core of the embedded system, Sensors and actuators, Communication interface, Embedded firmware	6
3	8051 Microcontroller: 8051 Architecture, timers and interrupts, Special function registers, Program/ data memory, addressing modes. instruction set, interrupts,	8
4	ARM Processor Fundamentals and Architectures, ARM Instruction Set, PIC Microcontroller and its Architecture.	10
5	Design and Development of Embedded product: Analog Electronic Components, Digital Electronic Components, Electronic design automation tools, Embedded firmware design approaches, Embedded firmware development languages	8

6	Integration and testing of embedded hardware and firmware, Embedded system development environment, Product enclosure design and development, Embedded product development life cycle, Trends in embedded industry	6
Total		42

Suggested Text Book(s):

1. Frank Vahid and Tony Givargis, "Embedded system design: A unified Hardware/Software introduction,"3rd Ed., Wiley 2014
2. Shibu K. V, "Introduction to Embedded Systems," 2nd Ed., McGraw Hill, 2017

Suggested Reference Book(s):

1. Steve Furber, "ARM System-on-Chip Architecture," 2nd Ed., Pearson 2012
2. Tim Wilmshurst, "Designing Embedded Systems with PIC Microcontrollers: Principles and Applications," 2nd Ed., Newnes, 2009
3. Steven F Barrett and Daniel J Pack, "Embedded Systems Design and Applications with the 68HC12 and HCS12," 1st Ed., Pearson 2012
4. Kenneth Ayala, "The 8051 microcontroller," 3rd Ed., Thomson, 2005

Other useful resource(s):

NPTEL ONLINE COURSES

1. Embedded Systems: https://nptel.ac.in/courses/108105057/ (Prof. A. Routray, Prof. Rajib Mall, Prof. Amit Patra, IIT Kharagpur)
2. Embedded Systems: https://nptel.ac.in/courses/108102045/ (Prof. Santanu Chaudhary, IIT Delhi)
3. Embedded Systems Design: https://nptel.ac.in/courses/106105159/ (Prof. Anupam Basu ,IIT Kharagpur)

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

CO/PO (Embedded System Design)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Average
CO1	2	X	2	1	2	X	X	X	X	X	3	1	0.92
CO2	3	3	3	2	3	2	X	X	2	3	X	3	2.00
CO3	3	2	3	2	3	2	X	X	1	2	X	2	1.67
CO4	3	2	3	2	3	2	X	X	1	X	X	2	1.50
CO5	3	2	3	2	3	2	X	X	X	X	X	2	1.42
CO6	3	2	3	2	2	3	X	X	2	2	1	1	1.75
Average	2.83	1.83	2.83	1.83	2.67	1.83	0.00	0.00	1.00	1.17	0.67	1.83	

FPGA based Instrumentation System Design

COURSE CODE: 18B1WEC733

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Digital Electronics, Basic Electronics

Course Objectives:

1. Learn and understand the FPGA design flow
2. Learn to implement basic arithmetic circuits and DSP algorithms in FPGA using IP cores.
3. Learn to determine circuit speed, to check timing violations and techniques to fix them.
4. Learn to apply the knowledge gained to break an algorithm into arithmetic functions and implement in FPGA with/without using IP cores.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Explain the concept and basic structures of Field Programmable Gate Array (FPGA), and techniques to implement programmable logic circuits using typical FPGA design flow	Familiarity
CO-2	Implementing basic arithmetic circuits and ASICs for simple DSP functions, such as filters using user defined or vendor provided IP cores	Assessment
CO-3	Determining circuit speed, checking timing violations and techniques to fix the timing violations.	Usage
CO-4	Design issues in cross clock domains communication in high-speed ASIC design	Assessment
CO-5	Break any given algorithm to sub-modules and implement the same on FPGA using HDLs and various IP cores	Usage

Course Contents:

Unit	Contents	Lectures required
1	Introduction to FPGA: From discrete logic to FPGAs, flexibility and functionality, FPGA vs Programmable DSPs, FPGA technology - roadmap, clocking, data and sample rates, slices and configurable logic blocks, memory and registers, performance ratings, families DSP and FPGAs: FPGA elements for DSP algorithms, FPGA-Based System Design Examples	6

2	Verilog HDL: Data types, operators, Multiplexers, decoders, adders, Subtractor, de-multiplexers, flip-flops, counters, state machine, ALU with adder/Subtractor and shifter, multiply and divide hardware synthesis, memory, using a test bench for verification and simulation Concept of state machine and VHDL implementation, simulation synthesis, verification, : FSM Types, Implementation in HDLs, a simple computer design, other Design examples and case studies	12
3	Digital System Design: Combinational and sequential circuits, Classification of sequential circuits, Registers. Design & analysis of synchronous and asynchronous sequential circuits: Counters.	6
4	Embedded Systems & FPGAs: FPGA as a systems on chip platform, FPGA on-chip network standards, FPGAs as custom microcontroller and hybrid DSP microcontroller devices, Multiple cock domains on chip, Multi FPGA systems, multiple-clock domains, program and data memory, SRAM and DRAM., ROM, PAL, and PLA, Timing Constraints, using IP cores: instantiation and simulations	6
5	Instrumentation System: Basic concepts, Weighted Resistor D/A converter, A/D Converter, programmable ICs, digital potentiometers, various data communication and interfacing protocols (UART, SPI, I2C and others) and FPGA implementation case studies	12
Total lectures		42

Suggested Text Book(s):

1. Michael D. Ciletti: Advanced Digital Design with the Verilog HDL, 2nd Edition, Pearson, 2011.
2. Jean- Pierre Deschamps, Gustavo D. Sutter, Enique Cano: Guide to FPGA Implementation of Arithmetic Functions, Springer, 2012.

Suggested Reference Book(s):

1. Hamblen, J.O, Hall, T.S, and Furman, M.D., “Rapid Prototyping of Digital Systems, SOPC Edition." Springer, 2008.
2. Zainalabedin, Navabi, "Digital Design and Implementation with Field Programmable Devices", Springer, 2005.
3. Jean- Pierre Deschamps, Gery Jean Antoine Bioul, Gustavo D. Sutter, “Synthesis of Arithmetic Circuits-FPGA ASIC and Embedded Systems” , a John Wiley & sons, inc, publication, 2006.

Other useful resource(s):

1. FPGA manufacturer’s web resources:

   Altera Inc.: https://www.altera.com/products/general/fpga/stratix-fpgas/about/stx-asic-prototyping.html

   Xilinx: https://www.xilinx.com/applications/asic-prototyping.html
2. Other Journal/research resources:

   http://biomedical-engineering-online.biomedcentral.com/articles/10.1186/1475-925X-13-126

   http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.470.6049&rep=rep1&type=pdf
3. NPTEL Resources

   https://nptel.ac.in/courses/117108040/

   https://nptel.ac.in/courses/117106092/55

https://nptel.ac.in/syllabus/117108040/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (FPGA based Instrumentation System Design)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	2	3	1	2	2	x	1	3	3	1	2	1.67
CO-2	3	2	3	1	2	2	x	x	3	1	1	2	1.67
CO-3	3	3	3	2	3	2	x	x	3	2	1	2	2.00
CO-4	3	3	3	2	3	2	x	x	3	2	1	2	2.00
CO-5	3	3	3	3	3	2	x	x	3	2	1	2	2.08
Average	3	2.6	3	1.8	2.6	2	0	0	3	1.6	1	2	

Real Time Operating Systems

COURSE CODE: XXXXXXXX

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Prerequisites are basic knowledge of computer architecture and operating systems

Course Objectives:

1. Study of design of real time operating systems and their operations.
2. Design and analysis of real time system software.
3. Modeling and verification of real time systems
4. Use real time system programming languages and real time operating systems for real time applications.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Fundamental principles for programming of real time systems with time and resource limitations.	Familiarity
CO-2	Foundation for programming languages developed for real time programming.	Assessment
CO-3	How real time operating systems are designed and functions.	Assessment
CO-4	Study of application domains.	Usage

Course Contents:

Unit	Contents	Lectures required
1	Introduction to UNIX/LINUX, Overview of Commands, File I/O,(open, create, close, lseek, read, write), Process Control (fork, vfork, exit, wait, waitpid, exec).	8
2	Brief History of OS, Defining RTOS, The Scheduler, Objects, Services, Characteristics of RTOS, Defining a Task, asks States and Scheduling, Task Operations, Structure, Synchronization, Communication and Concurrency. Defining Semaphores, Operations and Use, Defining Message Queue, States, Content, Storage, Operations and Use	8
3	Pipes, Event Registers, Signals, Other Building Blocks, Component Configuration, Basic I/O Concepts, I/O Subsystem	7
4	Exceptions, Interrupts, Applications, Processing of Exceptions and Spurious Interrupts, Real Time Clocks, Programmable Timers, Timer Interrupt Service Routines (ISR), Soft Timers, Operations.	7

5	RT Linux, Micro C/OS-II, Vx Works, Embedded Linux, and Tiny OS.	6
6	Fault – Tolerant Design: A Case Study, Case Study in Software Requirements Specification for Four way, Traffic Intersection Traffic Light Controller System.	6
Total lectures		42

Suggested Text Book(s):

1. Qing Li, "Real Time Concepts for Embedded Systems", 2011, Elsevier.

Suggested Reference Book(s):

1. Rajkamal, "Embedded Systems- Architecture, Programming, and Design", 2007, TMH.
2. W. Richard Stevens, Stephan A. Rago, "Advanced UNIX Programming", 2006, 2nd Edition, Pearson.
3. Dr. Craig Hollabaugh, "Embedded Linux: Hardware, Software and Interfacing", 2008, 1st Edition, Pearson.

Other useful resource(s):

Link to topics related to course:

1. https://nptel.ac.in/courses/106/105/106105172/
2. https://onlinecourses.nptel.ac.in/noc20_cs16/preview

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Real Time Operating Systems)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	3	3	2	1	1	1	2	2	2	2	1.91
CO-2	3	3	3	3	3	2	1	1	3	2	1	3	2.33
CO-3	2	3	2	2	2	2	2	2	2	2	1	2	2.00
CO-4	3	3	3	3	2	1	1	1	2	3	2	3	2.25
Average	2.50	2.75	2.75	2.75	2.25	1.50	1.25	1.25	2.25	2.25	1.50	2.50	

Digital CMOS ICs

COURSE CODE: _____

COURSE CREDITS: 3

CORE/ELECTIVE: PROFIENCY

L-T-P: 3-4-0

Pre-requisite: VLSI Technology (18B11EC612)

Course Objectives:

1. To understand and learn to use CMOS in designing combinational circuits, sequential circuits, semiconductor memories including the design of arithmetic building blocks.
2. To learn various low power CMOS logic design techniques including the clock and IO circuits design issues.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	To understand the MOS transistor as inverter, switch, its capacitance and CMOS logic gate design.	Familiarity
CO-2	To be able design and analyze combinational and sequential CMOS circuits and tradeoffs	Usage
CO-3	Able to design circuits using dynamic logic design technique	Usage, Assessment
CO-4	To understand and use the low power design techniques, methodologies and design practices to reduce the power dissipation of large scale CMOS digital ICs.	Assessment
CO-5	To understand the manufacturability and testability issues to be considered during the design phase of an IC	Familiarity

Course Contents:

Unit	Contents	Lectures required
1	Introduction to CMOS and its working as an inverter, review of delay time definitions, interconnect delay, switching power dissipation, sizing trends in CMOS inverter, delay constraints, MOSFETs, capacitances	5
2	Combinational logic circuits: Logic circuits with Pseudo-nMOS loads, CMOS Logic circuits, Complex logic circuits, CMOS Transmission Gates (Pass Gates)	5
3	Sequential Logic circuits: Behavior of bi-stable elements, SR Latch circuits, clocked latch and flip-flop circuits, clocked storage elements- timing parameters, CMOS D-latch and edge triggered Flip-Flop, Pulsed latch based clocked storage elements, Sense amplifier based Flip-Flops, Logic Embedding in clocked storage elements, Power consumption of clocking system and power saving methodologies.	11

4	Dynamic Logic circuits: Basic pass transistor circuits, voltage bootstrapping, synchronous dynamic circuit design techniques, Dynamic CMOS circuit design techniques, High performance Dynamic CMOS circuits	4
5	Dynamic Random access memory(DRAM), static random access memory (SRAM), Nonvolatile memory, Flash memory, Ferroelectric Random access memory (FRAM)	3
6	Low power CMOS Logic circuits: sources of power consumption, low power design through voltage scaling, estimation and optimization of switching activity, reduction of switched capacitance, adiabatic logic circuits	6
7	Design for manufacturability and testability: ESD protection, input circuits, output circuits and noise, On chip clock generation and distribution, latch-up and its prevention, process variations, design of experiments and performance modeling, parametric yield estimation, worst case analysis, performance variability minimization, fault types and models controllability and observability, adhoc testable design techniques, scan based techniques, built in self test (BIST), current monitoring tests	8
Total lectures		42

Suggested Text Book(s):

1. Sung-Mo Kang, Yusuf Leblebici, Chulwoo Kim: CMOS Digital Integrated Circuits Analysis and Design, fourth edition, Tata McGraw-Hill, 2016.
2. Thomas A. Demassa, Zack Ciccone: Digital Integrated Circuits, John Wiley & Sons (Asia) Pte., Ltd.
3. John P. Uyemura: Introduction to VLSI Circuits and Systems, John Wiley & Sons, Inc., 2002.

Suggested Reference Book(s):

1. Kaushik Roy, Sharat Prasad: Low power CMOS VLSI circuit Design, Wiley India, 2010.
2. Adel S. Sedra, Kenneth C. Smith: Microelectronics Circuits, 5th Ed., Oxford University, 2004.

Other useful resource(s):

1. Link to NPTEL course contents: https://nptel.ac.in/courses/108106069/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Class performance, Tutorials & Assignments - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Digital CMOS ICs)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO1	3	3	2	3	2	2	2	1	1	1	2	3	2.08
CO2	3	3	3	2	2	2	2	1	1	2	1	3	2.08
CO3	3	3	3	3	3	2	1	1	1	1	1	2	2
CO4	3	3	3	3	3	3	1	1	1	1	1	2	2.08
CO5	3	2	2	2	3	2	1	1	1	1	1	2	1.75
CO6	3	3	3	3	3	3	3	1	1	1	1	3	2.33
Average	3.00	2.83	2.67	2.67	2.67	2.33	1.67	1	1	1.17	1.17	2.50	

CAD Algorithms for Synthesis of Digital Systems

COURSE CODE: XXXXXXX

COURSE CREDITS: 3

CORE/ELECTIVE: Elective

L-T-P: 3-0-0

Pre-requisite: Digital Electronics

Course Objectives:

1. To learn modern techniques and algorithms for synthesis and optimization of digital systems.
2. To provide the basic exposure of technology mapping.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Able to understand the design flow for the implementation of the of digital systems hardware design.	Familiarity
CO-2	Able to understand the concept of optimization in logic synthesis	Usage
CO-3	Able to understand the concept of optimization in Multi level logic synthesis and sequential logics.	Usage
CO-4	Able to understand the algorithm for Boolean decomposition	Usage
CO-5	Able to use the CAD tools for the synthesis of digital systems	Assessment

Course Contents:

S. No.	Contents	Contact Hours
1.	Introduction: Intro to VLSI CAD & Logic Synthesis, Graph Theory & Optimization problems, Boolean Algebra, Boolean Function Representation & Manipulation: BDDs, Satisfiability & Graph Covering	06
2	Exact & Heuristic Two-Level Logic Minimization: SOP & POS forms: Costs & Characteristics, Implicants, Cubes and Covers, Quine-McCluskey Method, Minimum Cover via Unate Covering, Branch-and-Bound Methods, Multi-Output Function Minimization, Unate Recursive Paradigm ,The ESPRESSO Minimizer	06
3	Multi-Level Logic Synthesis - Algebraic Techniques: Combinational Network Representation and Transformations , Factored Forms and Algebraic Techniques Alegbraic Division: Kernels and Co-Kernals, Heuristic Factoring Algorithms, The MIS MODEL	08
4	Boolean Decomposition: Functional Decomposition – Basics, Ashenhurst-Curtis Decomposition, BDS and Bi-Decomposition, Don't Care Conditions & Their Computations, BDD-Based Boolean Decomposition 2, Decomposition for FPGAs • New Logic Synthesis approaches based on AND-Invert Graphs and Boolean Decomposition , The ABC Synthesis & Verification tool	08

5	Delay Optimization: Timing Analysis – Basics, False Path Analysis, Circuit Restructuring for Timing Optimization, Redundancy and Delay: KMS Algorithm Sequential Logic Optimization Finite State Machine Minimization, Two-Level Encoding: DIET & NOVA , Multi-Level Encoding: JEDI, Retiming of Sequential Circuits, Retiming, Resynthesis and Don't Cares Technology Mapping: Tree & DAG Covering, Standard Cell Mapping ,And-Invert Graphs ,Tech-mapping on FPGAs New Directions in Logic Synthesis : Limitations of Conventional Synthesis Tools, Multi-Valued Logic Synthesis, Reversible & quantum logic .	14
	Total	42

Suggested Text Book(s):

1. J. Bhasker, "Verilog VHDL synthesis: a practical primer", B S Publications, 1998.
2. Sait, S. M. and Youssef, Habib, VLSI Physical Design Automation – Theory and Practice, World Scientific, 2004.
3. Sherwani, N., Algorithms for VLSI Physicsl Design Automation, Springer. Third Ed. 2005.
4. Deba Prasad Das, VLSI design, Second Edition, Oxford Publishers, 2015
5. Micheli, Giovanni De. Synthesis and optimization of digital circuits. McGraw-Hill Higher Education, 1994.

Suggested Reference Book(s):

1. S. Ramachandran, "Digital VLSI systems design", Springer, 2007.
2. R.H. Katz, "Contemporary logic design", Addison-Wesley Pub. Co., 1993.
3. M.J.S. Smith, "Application-specific integrated circuits", Addison-Wesley Pub. Co., 1997.
4. M.L. Bushnell and V.D. Agrawal, "Essentials of Electronic Testing", Kluwer Academic Publishers, 2000.
5. D.D. Gajski, N.D. Dutt, A.C. Wu and A.Y. Yin, "High-level synthesis: introduction to chip and system design", Kluwer Academic Publishers, 1992.
6. Andrew B. Kahng, J. Lienig I. L. Markov,J. Hu, VLSI Physical Design: From Graph Partitioning to Timing Closure, Springer, 2011.

Other useful resource(s):

1. http://www.facweb.iitkgp.ac.in/~isg/CAD/SLIDES/01-intro.pdf
2. http://jjackson.eng.ua.edu/courses/ece380/lectures/LECT06.pdf
3. https://canvas.instructure.com/courses/1066166/modules
4. http://www.cs.columbia.edu/~cs6861/handouts/syllabus.pdf
5. https://my.ece.utah.edu/~kalla/ECE5740/syllabus.pdf
6. http://unina.stidue.net/Architettura%20dei%20Sistemi%20di%20Elaborazione/Materiale/G.%20De%20Micheli%20%20Synthesis%20And%20Optimization%20Of%20Digital%20Circuits%20%28Text%20Recognized%20Using%20OCR%29%20%5Bv.%201.03%2020-4-2005%5D.pdf

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered up to T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (CAD Algorithms for Synthesis of Digital Systems)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	3	2	2	3	3	3	3	3	3	3	2.8
CO-2	3	3	3	3	3	3	3	3	3	3	2	2	2.8
CO-3	3	3	3	3	2	2	2	3	2	3	3	2	2.6
CO-4	3	2	3	3	3	3	2	2	3	2	3	3	2.7
CO-5	3	3	3	3	3	3	3	3	3	3	3	3	3
Average	3	2.8	3	2.8	2.6	2.8	2.6	2.8	2.8	2.8	2.8	2.6	

Communication Engineering

COURSE CODE: 18B1WEC532

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Signals & Systems, Basic Course in Probability.

Course Objectives:

1. To understand the use of communication in the field of satellites and the concept of spread spectrum.
2. To make the students familiar with the implications of laws of information theory and coding with reference to the application in communication engineering.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Students will be familiar with the various fields/trends of communications like Satellite communication, Information theory and coding, and spread spectrum technique related to radio and telecommunication.	Familiarity
CO-2	To analyze the error performance of digital modulation systems in the presence of noise.	Assessment
CO-3	Design link power budget for satellite communication.	Assessment
CO-4	Design the channel based on given constraint using information theory.	Assessment
CO-5	Apply various codes like linear block codes, convolution codes etc. for channel performance analysis.	Usage
CO-6	Analyze the performance of spread spectrum systems in jamming environment.	Assessment

Course Contents:

Unit	Contents	Lectures required
1	Introduction to Baseband Transmission and Pass band Digital Modulation: Matched Filter, Inter Symbol Interference, Eye Pattern, Overview of ASK, FSK, PSK, and QAM, Basics of MSK, Signal Constellations, Probability of error analysis of modulation schemes.	6
2	Communication Link Analysis: The Channel, Error-Performance Degradation, Sources of Signal Loss and Noise, Received Signal Power and Noise Power, Link Budget Analysis, Noise Figure, Noise Temperature, System temperature, Sample Link Analysis.	9

3	Fundamental Limits in Information Theory: Uncertainty, Information, Entropy, Source-Coding Theorem, Data Compaction, Discrete Memoryless Channels, Mutual Information, Channel Capacity, Channel-Coding Theorem.	9
4	Error-Control Coding: Introduction, Linear Block Codes, Syndrome, Syndrome Decoding, Cyclic Codes, Generator Polynomial, Parity-Check Polynomial, Convolution Codes, Code tree, Trellis Diagram, Maximum Likelihood Decoding of Convolution Codes, Viterbi Algorithm.	10
5	Spread-Spectrum Modulation: Introduction, Pseudo-Noise Sequences, Direct Sequence Spread Spectrum with coherent BPSK, Signal-Space Dimensionality and Processing Gain, Frequency Hopping Spread Spectrum.	8
Total lectures		42

Suggested Text Book(s):

1. Simon Haykin, "Communication Systems", 4th Ed., John Wiley & Sons, 2004.
2. Bernard Sklar and P. K. Ray, "Digital Communications: Fundamentals and Applications", 2nd Ed., Pearson Education, 2012.

Suggested Reference Book(s):

1. B. P. Lathi and Zhi Ding, "Modern Digital and Analog Communication Systems", 4th Ed., Oxford, 2010.

Other useful resource(s):

Link to NPTEL course contents: https://nptel.ac.in/courses/117105131/16

Link to NPTEL course contents: https://nptel.ac.in/courses/117101053/1

Link to NPTEL course contents: https://nptel.ac.in/courses/117105136/1

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (1) - 5 Quizzes (2) - 15 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course Outcomes (Communication Engineering)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	3	3	1	2	1	2	1	2	2	3	2.17
CO-2	3	3	3	3	3	2	2	2	1	1	1	3	2.25
CO-3	3	3	3	3	2	3	3	2	1	2	3	3	2.58
CO-4	3	3	3	2	2	1	1	1	1	2	3	3	2.08
CO-5	3	3	3	2	3	2	1	2	1	2	3	3	2.33
CO-6	3	3	2	2	2	3	3	2	2	3	3	3	2.58
Average	3.00	3.00	2.83	2.50	2.17	2.17	1.83	1.83	1.17	2.00	2.50	3.00	

Optical Communication Systems

COURSE CODE: 18B1WEC633

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Communication Systems

Course Objectives:

1. To understand the constituents of the fiber optics communication system and optoelectronics.
2. To have an in depth knowledge of practically used optical communication systems

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Understand basics of optical communication systems.	Familiarity
CO-2	The principles that govern optical communication systems.	Familiarity
CO-3	Behavior of light as electromagnetic waves in different types of fibers.	Assessment
CO-4	The hardware components required to implement optical communication systems.	Assessment
CO-5	To efficiently design an optical communication system for practical purpose.	Usage
CO-6	The practical techniques involved in optical communication systems.	Usage

Course Contents:

Unit	Contents	Lectures required
1	Introduction: Fiber optics and Optoelectronics, Historical developments, Fiber optic communication system, Advantages, Emergence as a key technology, Role of Fiber optics technology.	5
2	Ray Propagation in Optical Fibers: Review of fundamental laws of optics, Ray propagation in Step-index and Graded-index Fibers, Effect of material dispersion, The combined effect of multipath and material dispersion, Calculation of rms pulse width.	8
3	Wave propagation in Waveguides: Maxwell's equations, Solution in a inhomogeneous medium, Planar optical waveguide, TE modes of a symmetric step-index planar waveguide, Power distribution and confinement factor, Modal analysis of an ideal SI optical fiber.	8
4	Single-mode Fibers and Multimode Fibers: Single-mode fibers, Characteristics parameters of SMFs, Dispersion in SMFs, Attenuation in SMFs, Graded-index fibers, Limitations of multimode fibers.	7

5	Optoelectronic Sources and Detectors: Fundamental aspects of semiconductor physics, the p-n junction, Current densities and injection efficiency, The basic principle of optoelectronic detection. Types of photodiodes, Photoconducting detectors, Noise considerations.	8
6	Optoelectronic Modulators and Amplifiers: Review of basic principles, Electro-optic modulators, Semiconductor optical amplifiers.	6
Total lectures		42

Suggested Text Book(s):

1. Optical Fiber Communications, John M Senior, 3rd Edition, PHI, 2009.
2. Fiber Optic Communication Systems, Govind P. Agarwal, 4th Edition, Wiley, 2010.
3. Fiber Optics and Optoelectronics, R.P. Khare Oxford University Press, 2015

Suggested Reference Book(s):

1. Fiber Optic Communications, S. Kumar and M. J. Deen, Wiley, 2014.
2. Optical Fiber Communications, G. Keiser, 5th Edition, Tata McGraw Hill, 2009.

Other useful resource(s):

1. Link to NPTEL course contents: https://nptel.ac.in/courses/117101002/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Optical Communication Systems)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	1.75
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	2
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	1.75
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	2.08
CO-5	2	3	3	3	2	1	1	1	2	3	2	2	2.08
CO-6	2	3	3	3	2	1	1	1	2	3	2	2	2.08
Average	2	2.66	2.66	2.66	2.66	1	1	1	2	2.5	1.66	2	

Next Generation Communication Systems

COURSE CODE: 18B1WEC732

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Basic knowledge of wireless communication and probability theory

Course Objectives:

1. To analyze the channel parameters effects on communication system.
2. Understanding of advanced techniques employed for improvement of communication system.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Understand the basics of communication system and various standards used in different generation.	Familiarity
CO-2	Understand the modeling of channel used in communication.	Familiarity
CO-3	Analyze the effect of various parameters on the performance of communication system.	Assessment
CO-4	Demonstrate the various techniques for performance improvement of communication system	Assessment
CO-5	Apply advanced techniques to next generation communication system	Usage

Course Contents:

Unit	Contents	Lectures required
1	CDMA: Introduction to various generation of cellular communication systems and standards, Introduction to CDMA and Spread Spectrum, Generation and Properties of PN Sequences, correlation between PN Sequences, Walsh Code, Variable tree OVSF, LFSR, Rake Receiver, Near-Far effect, Multi user CDMA uplink and downlink.	9
2	Channel Characterization of Next generation communication system: BER and SNR analysis of wired and wireless channels, Effect of various channel parameters on performance of wireless communication system, Doppler shift.	6
3	Diversity & Equalization: Diversity System Model, Receiver Diversity: selection diversity, feedback diversity, maximal ratio combining, equal gain combining, Equalizers, Types of Equalizers: linear equalizers, non-linear equalizers.	9
4	Principles of OFDM and MIMO wireless communication: Introduction to OFDM, OFDM Block Diagram, MIMO Wireless Communication, Benefits of MIMO Technology, MIMO OFDM Building Block, Capacity Comparisons of SISO, SIMO, MISO, and MIMO.	9

5	Singular Value Decomposition, Software Defined Radio , Cognitive Radio	9
Total lectures		42

Suggested Text Book(s):

1. T.S. Rappaport, "Wireless Communication", 2nd Edition, Prentice Hall., 2002.
2. A.Goldsmith, " Wireless communication" 1st Edition , Cambridge University Press,2005.
3. Ye Li and Gordon L. Stuber, "Orthogonal Frequency Division Multiplexing for Wireless Communications" 1st Edition, Springer, 2006.

Suggested Reference Book(s):

1. Huseyin Arslan: Cognitive Radio, Software Defined Radio, and Adaptive Wireless Systems, 1st Edition, Springer, 2007.
2. Hui Liu, "OFDM based broadband wireless networks: design and optimization" , 1st Edition, John Wiley & Sons, 2006.

Other useful resource(s):

1. Link to NPTEL course contents: https://nptel.ac.in/courses/117104099/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programmed Outcomes (POs)

Course outcomes (Next Generation Communication Systems)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	3	2	2	1	2	2	2	1	2	2	2	1.92
CO-2	3	3	3	3	2	2	1	1	1	2	2	2	2.08
CO-3	3	3	3	3	2	1	1	1	1	2	1	1	1.83
CO-4	2	3	3	2	2	1	1	1	1	2	1	3	1.83
CO-5	3	2	2	2	3	2	2	1	1	2	2	2	2.00
Average	2.6	2.8	2.6	2.4	2	1.6	1.4	1.2	1	2	1.6	2	

OFDM and Applications

COURSE CODE: 18B1WEC736

COURSE CREDITS: 3

CORE/ELECTIVE: Elective

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

1. Learn the fundamental concepts of high rate OFDM communication system focusing on the physical layer.
2. Analyze the design requirements of various OFDM standards.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Learn the fundamentals of OFDM communication system.	Familiarity
CO-2	Performance analysis of OFDM signals over AWGN and wideband channels.	Assessment
CO-3	Demonstrate the challenging issues in OFDM system.	Assessment
CO-4	Apply OFDM to the practical communication systems.	Usage

Course Contents:

Unit	Contents	Lectures required
1	Introduction and Basics of OFDM: High rate wireless applications; Wireless channel; Interference and noise; OFDM concept and system model- block diagram, design of the OFDM signal, OFDM system model, FFT implementation, cyclic extension, power spectrum and spectrum efficiency, synchronization errors; Channel capacity and OFDM; Comparison with single-carrier; Design example; Performance of an uncoded OFDM system.	10
2	Impairments of Wireless Channels to OFDM Signals: Time varying impairments; Effect of sampling clock offset; Effect of timing offset; Effect of delay spread; System Non Linearity. Other Multicarrier Modulation; Mathematical modeling and analytical evaluation of the BER of OFDM System.	8
3	OFDM Transmission over Gaussian channels and wideband channels. Synchronization: Overview of synchronization schemes- timing offset estimation, frequency offset estimation, acquisition versus tracking; Timing offset estimation- pilot based methods, non-pilot based methods; Frequency offset estimation- pilot based methods, non-pilot based methods; Joint time and frequency offset estimation and correction.	8

4	OFDM versus-MC-CDMA: Peak Power Ratio: The peak power problem; Distribution of PAP ratio; Maximum PAPR of an N subcarrier OFDM signal; PAPR reduction with signal distortion; Limits for distortion-less PAPR-reduction; Techniques for distortion-less PAPR reduction-selective mapping, optimization techniques, modified signal constellation; PAPR reduction effect on the system performance; PAPR reduction for multicarrier CDMA.	8
5	OFDM applications: MIMO OFDM- synchronization for MIMO OFDM, A practical OFDM system: Fixed broadband wireless access, system requirements, parameter selection, communication protocol, frame structure, MAC consideration and conformance.	8
Total lectures		42

Suggested Text Book(s):

1. Ye Li and Gordon L. Stuber: Orthogonal Frequency Division Multiplexing for Wireless Communications, 1st Edition, Springer, 2006.
2. Ramjee Prasad: OFDM for Wireless Communications Systems, 1st Edition, Artech House Publishers, 2004.
3. Lazos Hanzo: OFDM and MC-CDMA: A primer, 1st Edition, Wiley-IEEE Press, 2006

Suggested Reference Book(s):

1. Richard Van Nee: OFDM for Wireless Multi-Media Communication, 1st Edition, Artech, House Publishers, 2000.
2. Hui Liu: OFDM based Broadband Wireless Networks: Design and Optimization, 1st Edition, John Wiley & Sons, 2006.

Other useful resource(s):

1. Link to NPTEL course contents: https://nptel.ac.in/courses/117104099/
2. Link to topics related to course:
   https://nptel.ac.in/courses/117104099 /27
   https://nptel.ac.in/courses/117104099 /28
   https://nptel.ac.in/courses/117104099 /29
   https://nptel.ac.in/courses/117104099 /30
   https://nptel.ac.in/courses/117104099 /31
   https://nptel.ac.in/courses/117104099 /34

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (OFDM and its Applications)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	2	3	1	3	1	1	1	2	2	1	3	1.92
CO-2	3	3	3	3	3	2	1	1	2	2	1	3	2.25
CO-3	2	2	3	3	2	1	1	1	2	1	1	3	1.83
CO-4	2	1	3	3	3	2	1	1	1	1	1	2	1.75
Average	2.5	2	3	2.5	2.75	1.5	1	1	1.75	1.5	1	2.75	

Cognitive Radio Networks

COURSE CODE: 18B1WEC834

COURSE CREDITS: 3

CORE/ELECTIVE: Elective

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

1. To understand the principles, applications and challenges of cognitive radio technology.
2. Analyze the design of wireless networks based on cognitive radio technology.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Understand the fundamental issues regarding dynamic spectrum access and radio-resource management.	Familiarity
CO-2	Analyze the emerging issues in cognitive radio network.	Assessment
CO-3	Apply different spectrum sharing models in the Cognitive Radio Network.	Assessment
CO-4	Apply efficient sharing of the unutilized spectrum among cognitive and licensed users while avoiding interference to the licensed user due to cognitive user's transmission	Usage

Course Contents:

Unit	Contents	Lectures required
1	Introduction to Cognitive Radio: Spectrum scarcity, Spectrum white space, Fixed spectrum allocation, Software defined radio (SDR), Limitations of SDR, Evolution of cognitive radio, Dynamic spectrum access, Introduction to cognitive radio concept, Cognitive cycle, Functions of cognitive radio; spectrum sensing, spectrum management, spectrum mobility, Cognitive radio architecture, Interference temperature and its models.	8
2	Spectrum Sensing and Challenges in Cognitive Radio Network: Hypothesis model for spectrum sensing, Types of spectrum sensing; Non-cooperative sensing, Cooperative sensing, Interference-based sensing, Matched filter detection, Energy detection, Cyclostationary feature detection, advantages and disadvantages of various spectrum sensing techniques, False alarm, Miss detection, Optimal sensing framework for infrastructure based cognitive radio network. Research challenges in spectrum sensing, spectrum management and spectrum mobility, potential applications of cognitive radio, IEEE 802.22 for WRANs	8

3	Spectrum Sharing and Management: Dynamic spectrum Access (DSA): models and architectures, Opportunistic spectrum access (OSA), Antenna Systems, MIMO systems, Smart antenna and beamforming. SDR architecture, Software tunable analog radio components, Reconfigurable digital radio technologies.	8
4	Cross Layer Adaptation and Security in Cognitive Radio: Why we need cross-layer design, adaptation and optimization, Cognitive radio cross layer design, security challenges in cognitive radio. OFDM for Cognitive Radio: OFDM based cognitive radio, Why OFDM is a good fit for Cognitive radio, Challenges to cognitive OFDM systems, Multiband OFDM, A step toward cognitive-OFDM: standards and technologies.	9
5	Cognitive Radio Regulation and Standardization: regulatory issues and new spectrum management regimes, spectrum planning, Spectrum authorization, Standards and international activities. UWB Cognitive Radio: Introduction, Fundamentals of impulse radio Ultra Wideband, Cognitive radio requirements versus IR-UWB, Merging impulse radio with cognitive radio.	9
Total lectures		42

Suggested Text Book(s):

1. Ekram Hossain, Dusit Niyato and Zhu Han: Dynamic Spectrum Access and Spectrum Management in Cognitive Radio Networks, 1st Edition, Cambridge University Press, 2009.
2. Huseyin Arslan: Cognitive Radio, Software Defined Radio, and Adaptive Wireless Systems, 1st Edition, Springer, 2007.
3. Bruce A. Fette: Cognitive Radio Technology, 2nd Edition, Academic Press, April 6, 2009.

Suggested Reference Book(s):

1. Yang Xiao and Fei Hu: Cognitive Radio Networks, 1st Edition, CRC Press, 2008.
2. Linda E. Doyle: Essentials of Cognitive Radio, 1st Edition, Cambridge University Press, 2009.

Other useful resource(s):

Link to GIAN IIT Kanpur course contents (10 lecture series):
https://www.youtube.com/watch?v=SljXFf0vgvw&list=PL48UwQJyfW3SmrjLgl5LrVciqfWz9XazY

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Cognitive Radio Networks)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	2	2	2	2	1	2	1	2	2	3	2.08
CO-2	3	3	3	3	2	1	1	1	2	2	1	2	2
CO-3	3	3	3	2	2	2	1	2	2	2	1	3	2.17
CO-4	3	3	3	3	2	1	1	1	2	3	2	3	2.25
Average	3	3	2.75	2.5	2	1.5	1	1.5	1.75	2.25	1.5	2.75	

Wireless Communication and Mobile Networks

COURSE CODE:

COURSE CREDITS: 3

CORE/ELECTIVE: CORE

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

1. To introduce students to the basic concepts and techniques of wireless communication.
2. To become familiar with technology employed in next generation of mobile communication.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Understanding of evaluation of wireless system	Familiarity
CO-2	Acquire knowledge of cellular systems	Familiarity
CO-3	Modelling and analysis of fading channels in wireless system	Usage
CO-4	In depth knowledge of various techniques used in wireless mobile system.	Assessment
CO-5	Understanding of GSM, 4G and 5 G network	Assessment

Course Contents:

Unit	Contents	Lectures required
1.	Introduction to wireless and mobile communication: Evolution of mobile radio communication fundamentals. General model of wireless communication link, Types of Signals, Cellular Infrastructure, Cellular System Components, Antennas for Cellular Systems, Operation of Cellular Systems,	5
2.	Channel Assignment, Frequency reuse, Channel Assignment strategies, Handoff Strategies Cellular Interferences, Sectorization; Wireless Channel and Radio Communication, Free Space Propagation Model, Channel Noise and Losses, Fading in Land Mobile Systems, Multipath Fading, Fading Effects on Signal and Frequency, Shadowing.	5
3.	Wireless Channel Modeling: AWGN Channel, Rayleigh Channel, Rician Fading Channel, Nakagami Fading Channel, Ocumura and Hata Path Loss Model; Channel Modelling: Stochastic, Flat Fading, Wideband Time Dispersive Channel Modelling	8

4.	Theory of Vocoders, Types of Vocoders; Spread Spectrum Modulation, Pseudo-Noise Codes with Properties and Code Generation Mechanisms, DSSS and FHSS Systems, Time Hopping and Hybrid Spread Systems; Multicarrier Modulation Techniques. Zero Inter Symbol Interference Communication Techniques, Detection Strategies, Diversity Combining Techniques: Selection Combining, Threshold Combining, Equal Gain Combining, Maximum Ratio Combining; Spatial Diversity and Multiplexing in MIMO Systems, Channel Estimation.	9
5.	Equalization Techniques: Adaptive Equalizers, Zero Forcing Equalizers, Decision Feedback Equalizers, GSM system for mobile Telecommunication: GSM Architecture, Fundamentals of GSM Network, GSM Channels, Waveform Coding and Call Flow in GSM, Waveform Coding, GSM Vocoders, Call flow in GSM.	9
6.	Introduction to 4G, 5G and concept of NGN	6
Total lectures		42

Suggested Text Book(s):

1. T.S. Rappaport, "Wireless Communication", 2nd Edition, Prentice Hall., 2010.
2. A.Goldsmith, " Wireless communication" 1st Edition , Cambridge University Press, 2005.

Suggested Reference Book(s):

1. G. S. Rao, " Mobile Cellular Communication", Pearson Education, 2012.
2. K. Feher, "Wireless Digital Communications", PHI,1999.

Other useful resource(s):

1. Link to NPTEL course contents: Advanced 3G and 4G Wireless Mobile Communications

https://www.youtube.com/watch?v=-ymnQ5rpcYA&list=PLbMVogVj5nJSi8FUsvglRxLtN1TN9y4nx

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered up to T-1
2	T-2	25	1.5 Hours	Syllabus covered up to T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs):

CO/PO (Wireless Communication and Mobile Networks)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO1	2	3	2	2	2	2	2	1	1	2	3	3	2.08
CO2	2	3	3	2	3	2	2	1	1	2	2	3	2.16
CO3	3	2	3	3	3	3	1	2	3	3	3	3	2.66
CO4	3	3	3	3	3	3	3	1	3	3	3	2	2.75
CO5	3	3	2	3	3	3	3	1	3	3	3	3	2.75
Average	2.6	2.8	2.6	2.6	2.8	2.6	2.2	1.2	2.2	2.6	2.8	2.8	

Introduction to Machine Learning

COURSE CODE:

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

1. To introduce students to the basic concepts and techniques of Machine Learning.
2. To become familiar with regression methods, and classification methods.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Gain knowledge about basic concepts of Machine Learning	Familiarity
CO-2	Understand complexity of Machine Learning algorithms and their limitations	Familiarity
CO-3	Solve the problems using various machine learning techniques	Usage
CO-4	Design application using machine learning techniques	Assessment
CO-5	Capable of performing experiments in Machine Learning using real-world data.	Assessment

Course Contents:

Unit	Contents	Lectures required
1	Introduction: Overview of intelligent systems and machine learning, Supervised learning, Unsupervised learning, Reinforcement learning, Bias-variance trade-off, Overfitting, Underfitting, Goals and applications of machine learning	5
2	Linear Regression with One Variable: Model representation, Cost function, Gradient descent, Gradient descent for linear regression	4
3	Linear Algebra: Matrices and vectors, Addition and scalar multiplication, Matrix vector multiplication, Matrix multiplication, Matrix multiplication properties, Inverse and transpose, Multivariable calculus, and Modern applications	3
4	Linear Regression with Multiple Variables: Multiple features, Gradient descent for multiple variables, Feature scaling, Learning rate, Features and polynomial Regression, Normal equation, Noninvertibility	6

5	Logistic Regression: Classification, Hypothesis representation, Decision boundary, Cost function, Simplified cost function and Gradient descent, Advanced optimization, Multiclass classification: One-vs-all	6
6	Bayesian Learning: Probability theory and Bayes rule, Naive Bayes learning algorithm, Parameter smoothing, Generative vs. discriminative training, Bayes nets and Markov nets for representing dependencies.	6
7	Regularization: The Problem of overfitting, Cost function, Regularized linear regression, Regularized logistic regression	4
8	K-Nearest Neighbours: Introduction, KNN algorithm, Parameter selection , KNN as Classifier, KNN as Regressor, Applications	4
9	Machine Learning System Design: Error analysis, Error metrics for skewed classes, Trading off precision and recall, Data for Machine Learning	4
Total lectures		42

Suggested Text Book(s):

1. C. Bishop: Pattern Recognition and Machine learning, Springer, 2006.
2. H. Daume: A course in Machine leaning, 2015.
3. Ethem Alpaydin, "Introduction to Machine Learning", Second Edition, The MIT Press, Cambridge, 2010.

Suggested Reference Book(s):

1 T. Hastie, R. Tibshirani, J. Friedman: The Elements of Statistical Learning: Data Mining, Inference, and Prediction, Springer, 2013.

2. Stephen Marsland, "Machine Learning: An Algorithmic Perspective", Second Edition, Chapman and Hall/CRC, 2014.

Other useful resource(s):

1. Link to NPTEL course contents: Introduction to Machine Learning https://onlinecourses.nptel.ac.in/noc17_cs26/preview
2. Link to MITOPENCOURESEWARE: Machine Learning https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-867-machine-learning-fall-2006/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered up to T-1
2	T-2	25	1.5 Hours	Syllabus covered up to T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

CO/PO (Introduction to Machine Learning)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO1	3	3	2	2	2	2	2	1	1	2	3	3	2.17
CO2	3	3	3	2	3	2	2	1	1	2	3	3	2.33
CO3	3	3	3	3	3	3	3	1	3	3	3	3	2.83
CO4	3	3	3	3	3	3	3	1	3	3	3	3	2.83
CO5	3	3	3	3	3	3	3	1	3	3	3	3	2.83
Average	3.00	3.00	2.80	2.60	2.80	2.60	2.60	1.00	2.20	2.60	3.00	3.00	

Machine Learning for Data Analysis

COURSE CODE:

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Introduction to Machine Learning (20B1WEC531)

Course Objectives:

1. To provide a broad survey of approaches and techniques in machine learning;
2. To develop the design and programming skills that will help you to build intelligent, adaptive artifacts.
3. To develop the basic skills necessary to pursue research in machine learning.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Understand the basic theory underlying machine learning.	Familiarity
CO-2	Understand a range of machine learning algorithms along with their strengths and weaknesses.	Usage
CO-3	Apply machine learning algorithms to solve problems of moderate complexity.	Assessment
CO-4	Formulate machine learning problems corresponding to different applications.	Assessment
CO-5	Read current research papers and understand the issues raised by current research.	Usage

Unit	Contents	Lectures required
1	Introduction: Definition of learning systems, Goals and applications of machine learning, Aspects of developing a learning system: training data, concept representation, function approximation.	3
2	Data Exploration and Pre-processing: Data objects and attributes; Statistical measures, Visualization, Data cleaning and integration	4
3	Decision Tree based Learning: Decision tree induction, Attribute selection and tree pruning.	5
4	Support Vector Machines: Maximum margin linear separators, Quadractic programming solution to finding maximum margin separators, Kernels for learning non-linear functions.	5
5	Dimensionality Reduction: Discriminant analysis; Principal component analysis, Independent component analysis; Transform Domain and statistical feature extraction and reduction.	7
6	Clustering and Unsupervised Learning: Learning from unclassified data,	8

	Clustering, Hierarchical Aglomerative Clustering, k-means clustering, Density based clustering.	
7	Artificial Neural Networks: Single layer neural network, Multilayer Perceptron, Back Propagation learning, Functional link artificial neural network, Radial basis function network, Recurrent neural networks, Convolution neural network.	10
Total lectures		42

Suggested Text Book(s):

1. J. Watt, R. Borhani and A. K. Katsaggelos: Machine Learning Refined: Foundations, Algorithms and Applications, Cambridge University Press, 1st ed., 2016.
2. C. Bishop: Pattern Recognition and Machine Learning, Springer, 1st ed., 2006.
3. J. Han, M. Kamber, J. Pei: Data Mining: Concepts and Techniques, Elsevier Amsterdam, 3rd ed., 2011

Suggested Reference Book(s):

1. T. Hastie, R. Tibshirani, J. Friedman: The Elements of Statistical Learning: Data Mining, Inference, and Prediction, Springer, 2013.
2. H. Simon: Neural Networks and Learning Machines, Prentice Hall, 3rd ed., 2009.

Other useful resource(s):

1. H. Daume: A course in Machine Leaning, 2015. http://ciml.info/
2. Link to NPTEL course contents: Introduction to Machine Learning https://onlinecourses.nptel.ac.in/noc17_cs26/preview
3. Link to MITOPENCOURESEWARE: Machine Learning
https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-867-machine-learning-fall-2006/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (3) - 10 Quizzes (3) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Machine Learning and Data Analytics)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	2	2	2	2	2	1	1	2	3	3	2.17
CO-2	3	3	3	2	3	2	2	1	1	2	3	3	2.33
CO-3	3	3	3	3	3	3	3	1	3	3	3	3	2.83
CO-4	3	3	3	3	3	3	3	1	3	3	3	3	2.83
CO-5	3	3	3	3	3	3	3	1	3	3	3	3	2.83
Average	3.00	3.00	2.80	2.60	2.80	2.60	2.60	1.00	2.20	2.60	3.00	3.00	

Pattern Analysis in Machine Intelligence

COURSE CODE: XXXXXXXX

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

1. To introduce the concept of patterns for data analysis.
2. To analyze patterns to make machine take some decision.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Understand the concept and representation of patterns in different data.	Familiarity
CO-2	Understand and able to visualize the concept and methodology of different feature extraction and feature selection methods.	Usage
CO-3	Able to understand the methodology of different classifiers.	Assessment
CO-4	Understand the concept of unsupervised learning for pattern recognition.	Assessment
CO-5	Able to implement different classifiers and their combinations for different applications.	Usage

Course Contents:

Unit	Contents	Lectures required
1	Introduction: Definitions, data sets and Different Paradigms of Pattern Recognition, Representations of Patterns and Classes.	6
2	Feature Extraction and Selection: Metric and non-metric proximity measures, Feature extraction and different approaches to Feature Selection.	12
3	Introduction to Supervised learning: Bayes Classifier, Decision Trees, Linear Discriminant Function and Support Vector Machines.	12
4	Introduction to Unsupervised learning: Clustering Methods	6
5	Combination of Classifiers for different applications.	6
Total lectures		42

Suggested Text Book(s):

1. R. O. Duda, P.E. Hart and D. G.Stork,,"Pattern Classification", 2nd Ed., Wiley, 2000.
2. H. Simon, "Neural Networks and Learning Machines",3rd ed., Prentice Hall, 2009.

Suggested Reference Book(s):

1. Jiawei Han, Jian Pei, Micheline Kamber, "Data Mining: Concepts and Techniques", 3rd ed., Elsevier Amsterdam, 2011.
2. C. Bishop, "Pattern Recognition and Machine learning", 1st ed., Springer, 2006.

Other useful resource(s):

1. https://nptel.ac.in/courses/117105101/ (Prof P.K. Biswas, IIT Kharagpur)
2. http://www.cs.ucsb.edu/~yfwang/courses/cs290i_prann/index.html (Prof. Yuan-Fang Wang)

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes(2) -10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Pattern Recognition in Machine Intelligence)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	2	3	3	1	1	1	1	3	1	3	2.2
CO-2	3	3	3	3	3	1	1	1	2	3	1	3	2.2
CO-3	3	3	3	3	3	2	2	2	2	3	1	3	2.5
CO-4	3	3	3	3	3	2	2	2	2	3	1	3	2.5
CO-5	3	3	3	3	3	2	2	2	2	3	2	3	2.6
Average	3	3	2.8	3	3	1.6	1.6	1.6	1.8	3	1.2	3	

Optimization Techniques

COURSE CODE:

COURSE CREDITS: 3

CORE/ELECTIVE: Elective

L-T-P: 3-0-0

Pre-requisite: Basics of engineering mathematics

Course Objectives:

1. To lay strong foundations in understanding the importance of optimization techniques.
2. To apply the theoretical knowledge acquired to various applications.
3. To analyze and appreciate variety of performance measures for various optimization problems.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	To formulate and solve linear programming problems.	Familiarity
CO-2	To solve the problems on networks models such as Transportation, Assignment, Shortest path, minimal spanning tree, and Maximal flow.	Usage
CO-3	To solve the problems of Project Management using CPM and PERT	Usage
CO-4	Solve Non-linear Programming problems of some kinds.	Familiarity and Usage

Course Contents:

Unit	Contents	Lectures required
1	Introduction to Operation Research: Operation Research approach, scientific methods, introduction to models and modeling techniques, general methods for Operation Research models, methodology and advantages of Operation Research, history of Operation Research.	8
2	Linear Programming (LP): Introduction to LP and formulation of Linear Programming problems, Graphical solution method, alternative or multiple optimal solutions, Unbounded solutions, Infeasible solutions, Maximization – Simplex Algorithm, Minimization – Simplex Algorithm using Big-M method, Two phase method, Duality in linear programming, Integer linear programming.	8
3	Transportation & Assignment Problems: Introduction to Transportation problems, various methods of Transportation problem, Variations in Transportation problem, introduction to Assignment problems, variations in Assignment problems.	6

4	Network Analysis: Network definition and Network diagram, probability in PERT analysis, project time cost trade off, introduction to resource smoothing and allocation.Sequencing: Introduction, processing N jobs through two machines, processing N jobs through three machines, processing N jobs through m machines.	8
5	Inventory Model: Introduction to inventory control, deterministic inventory model, EOQ model with quantity discount.	6
6	Non-Linear Programming: Characteristics, Concepts of convexity, maxima and minima of functions of n-variables using Lagrange multipliers and Kuhn-Tuker conditions, One dimensional search methods, Fibonacci, golden section method and gradient methods for unconstrained problems.	6
Total lectures		42

Suggested Text Book(s):

1. J K Sharma, Operations Research Theory and Applications, MacMillan India Ltd.
2. N D Vohra, Quantitative Techniques in management, Tata McGraw Hill.
3. Handy A Taha, Operations Research – An Introduction, Prentice Hall of India, New Delhi.

Suggested Reference Book(s):

1. Wagner H M, Principles of Operations Research: With Applications to Management Decisions, Prentice-Hall of India, New Delhi.
2. Hillier F S and Lieberman G J, Operations Research, Holden Day Inc., San Francisco.
3. Payne T A, Quantitative Techniques for Management: A Practical Approach, Reston Publishing Co. Inc., Virginia.
4. Wilkes F M, Baum P and Smith G D, Management Science: An introduction, John Wiley and Sons, Santa Barbara.

Other useful resource(s):

1. Link to NPTEL course contents: https://nptel.ac.in/courses/111/105/111105039/ https://nptel.ac.in/courses/105/108/105108127/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Optimization Techniques)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	2	1	1	1	2	1	2	1.7
CO-2	2	3	2	3	2	2	1	1	1	2	1	2	1.8
CO-3	3	3	3	3	3	2	1	1	1	2	1	2	2.1
CO-4	2	2	2	2	2	2	1	1	1	3	1	2	1.8
Average	2.25	2.5	2.25	2.5	2.25	2.0	1.0	1.0	1.0	2.25	1.0	2.0	

Artificial Intelligence Techniques

COURSE CODE: 18B1WEC838

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Prerequisites are good programming skills, basic data structures and algorithms, and some university level mathematics.

Course Objectives:

1. Learn to create expert systems which exhibit intelligent behavior.
2. Learn to create expert systems which exhibit the capability to learn, demonstrate, explain and advice its users.
3. Learn to help machines finding solutions to the complex problems.
4. Learn to design human like machines in a computer friendly manner.
5. To study State of the Art algorithms with engineering applications.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Analyze the need and foundation of Artificial Intelligence	Familiarity
CO-2	Study the Intelligent agents that receive percepts from the environment and perform actions	Assessment
CO-3	Analysis of problem solving, knowledge and reasoning	Assessment
CO-4	Study of application domains.	Usage

Course Contents:

Unit	Contents	Lectures required
1	Introduction to Artificial Intelligence (AI): The History and foundations of AI, Philosophy of AI, Intelligent Agents and Knowledge based Systems, AI Problem Solving, AI Learning and AI Perception, Real World AI.	8
2	Intelligent Agents: Agents and Environments, The concept of Rationality, Performance Measures, The structure of Agents, Agent Programs, Simple reflex Agents, Model based reflex Agents, Goal based Agents, Utility based Agents, Learning Agents.	8
3	Problem Solving: Problem solving Agents, Formulating Problems, Searching for Solutions, Uninformed Search Strategies, Breadth first search, Depth first search, Depth limited Search, Bidirectional search, Informed Search Exploration, Constraint Satisfaction Problems.	7

4	Knowledge and Reasoning: Knowledge based agents, Reasoning Patterns in Propositional Logic, Forward and Backward Chaining, Back tracking Algorithm, First Order Logic, Knowledge Representation, Uncertain Knowledge and Reasoning	7
5	Learning, Perception and Action: Learning from Observations, Forms of Learning, Inductive Learning, Learning Decision Trees, Ensemble Learning, Knowledge in Learning, Statistical Learning, Reinforcement Learning, Perceptional Analysis, Communication as Action	6
6	Applications of AI Techniques: Semantic Interpretation, Probabilistic Language Processing, Robotic Hardware and Software Architectures, Probabilistic Inference, Planning and Search, Localization, Tracking and Control.	6
Total lectures		42

Suggested Text Book(s):

1. Stuart J. Russel and Peter Norvig: Artificial Intelligence: A Modern Approach, Third Edition, Pearson Education Limited, 2014.
2. E. Rich and K. Knight: Artificial Intelligence and Applications, Third Edition, Tata McGraw Hill, 2012.

Suggested Reference Book(s):

1. P. Kulkarni and P. Joshi: Artificial Intelligence, Second Edition, PHI Learning Private Limited, 2015.
2. P. H. Winston: Artificial Intelligence and Applications, Third Edition, PHI Learning Private Limited, 2017.

Other useful resource(s):

Link to topics related to course:

https://nptel.ac.in/courses/106105077/

https://nptel.ac.in/courses/106105079/

https://www.tutorialspoint.com/artificial_intelligence/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Artificial Intelligence Techniques)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	3	3	2	1	1	1	2	2	2	2	1.91
CO-2	3	3	3	3	3	2	1	1	3	2	1	3	2.33
CO-3	2	3	2	2	2	2	2	2	2	2	1	2	2.00
CO-4	3	3	3	3	2	1	1	1	2	3	2	3	2.25
Average	2.50	2.75	2.75	2.75	2.25	1.50	1.25	1.25	2.25	2.25	1.50	2.50	

Soft Computing Techniques

COURSE CODE: 18B1WEC832

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

1. Develop the skills to gain a basic understanding of neural network theory and fuzzy logic theory.
2. Introduce students to artificial neural networks and fuzzy theory from an engineering perspective

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Comprehend the fuzzy logic and the concept of fuzziness and concepts of neural networks	Familiarity
CO-2	Demonstrate knowledge representation using fuzzy rules, approximate reasoning, fuzzy inference systems, and fuzzy logic	Assessment
CO-3	Understand appropriate learning rules for each of the architectures and learn several neural network paradigms and its applications	Assessment
CO-4	Apply fuzzy rules and neural network learning rules and design paradigms to solve engineering and other Problems.	Usage

Course Contents:

Unit	Contents	Lectures required
1	Introduction to fuzzy set theory: Probabilistic reasoning, Fuzzy sets, mathematics of fuzzy set theory, operations on fuzzy sets, comparison of fuzzy and crisp set theory.	4
2	Fuzzy mapping: one to one mapping, max-min principle, extension principle, implication rules – mamdani implications. Membership functions: Universe of discourse, mapping inside fuzzy domain, fuzzy membership mapping methods, and application to real world problems.	10
3	Artificial Neural Networks (ANN) and their biological roots and motivations. Comparison Between Artificial and Biological Neural Networks, Applications of Neural network. Network Architecture ,Taxonomy of neural networks: feed forward and recurrent networks with. Merits and limitations of neurocomputing.	8
4	Types of learning, supervised and unsupervised learning laws . Learnig Laws : Hebb's rule, Delta rule, Widrow - Hoff (The Least-Mean-Square) learning rule, correlation learning rule, instar and outstar learning rules, Competitive learning, Credit Assignment Problem, Error Correction learning, Memory based learning.	9

5	The Perceptron and its learning law, Classification of linearly separable patterns, Multi-Layer Perceptron, Supervised Learning, Back-Propagation Learning law. Feed forward networks, Recurrent Networks.	6
6	Winner takes-all Networks, Competitive Learning, Kohonen's Self organizing Maps, Introduction to Adaptive Resonance Theory.	5
Total lectures		42

Suggested Text Book(s):

1. Simon Haykin: Artificial Neutral Networks, 2nd Edition, Pearson, 2008.
2. Yegna Narayanan: Artificial Neural Networks, 2nd Edition, Prentice-Hall of India, 2010.
3. S.N. Sivanandam, S.N Deepa: Principles of Soft Computing, 3rd Edition, Wiley, 2019.

Suggested Reference Book(s):

1. Bart Kosko: Neural Network and Fuzzy Systems: A Dynamic System Approach to Machine, Prentice-Hall 1998
2. L. Fausett: Fundamentals of Neural Networks: Architectures, Algorithms, and Applications, Prentice-Hall, Reprint 2013
3. Jack M. Zurada: Introduction to Artificial Neural Systems, PWS Publishing Co., 2nd Edition, 2002.

Other useful resource(s):

Link to NPTEL course contents

1. http://nptel.ac.in/courses/117105084/
2. http://nptel.ac.in/courses/108104049/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Soft Computing Techniques)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	2	2	2	3	2	1	1	1	2	2	2	1.92
CO-2	3	2	3	3	3	1	1	1	1	2	2	2	2.00
CO-3	3	2	3	3	3	2	1	1	1	2	2	2	2.08
CO-4	3	3	3	3	3	2	3	1	1	3	3	3	2.58
Average	3	2.25	2.75	2.75	3	1.75	1.5	1	1	2.25	2.25	2.25	2.15

Statistical Signal Processing

COURSE CODE: XXXXXXX

COURSE CREDITS: 3

CORE/ELECTIVE: Elective

L-T-P: 3-0-0

Pre-requisite: Principles of Digital Signal Processing (18B11EC511)

Course Objectives:

1. To understand signal models, signal characterization, and spectral estimation.
2. To understand, theory, implementation, and applications of statistical signal processing methods.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Able to understand the autoregressive, moving average, autoregressive moving average, and general linear models and how they relate to signal processing	Familiarity
CO-2	Able to apply wiener filter and adaptive filter for filtering and noise cancellation.	Usage
CO-3	Able to apply nonparametric techniques for spectral estimation	Usage
CO-4	Able to understand the cross-power spectral density, coherence, and apply time-frequency analysis tools for different application.	Familiarity & Usage
CO-5	Able to implement and apply these skills for different applications or projects.	Assessment

Course Contents:

S. No.	Contents	Contact Hours
1.	Introduction, Discrete-Time Processing, Discrete-Time Systems, Random Variables, Stochastic Signals, Estimation Theory, Signal Models, Autocorrelation, Windowing, IMPLEMENTATION IN PYTHON OR MATLAB	6
2	Linear Estimation, Optimum FIR Filters, Linear Prediction, Optimum IIR Filters, Optimum Linear Filter Applications, Kalman Filter, Extended Kalman Filter, Least-Squares Estimation, Implementation in PYTHON OR MATLAB.	8
3	Spectral Estimation, Non-Parametric Methods, Minimum Variance Spectrum Estimation, Maximum Entropy Method, Frequency Estimation Method, Parametric Methods, Principal Component Spectrum Estimation Method, Implementation in PYTHON OR MATLAB.	16
4	Joint Signal Analysis, Coherence Analysis, Time-Frequency Analysis, Implementation in PYTHON OR MATLAB.	8
5.	Adaptive Filtering, FIR Adaptive Filter, Implementation in PYTHON or MATLAB.	4
	Total	42

Suggested Text Book(s):

1. M. H. Hayes, Statistical Digital Signal Processing and Modelling, John Wiley & Sons, Student Edition, 2013.
2. D.G. Manolakis, V.K. Ingle and S.M. Kogon: Statistical and Adaptive Signal Processing, Artech House publishers, 2005.

Suggested Reference Book(s):

1. John G, Charles M. Algorithms for statistical signal processing. Prentice Hall, London; 2002.
2. Simon Haykin, Adaptive Filter Theory, Prentice Hall, 1996

Other useful resource(s):

1. https://nptel.ac.in/courses/108/103/108103158/#
2. http://web.cecs.pdx.edu/~ssp/
3. http://www.eas.uccs.edu/~mwickert/ece5615/lecture_notes/
4. http://www.eas.uccs.edu/~mwickert/ece5615/lecture_notes/N5615_1.pdf

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered up to T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Statistical Signal Processing)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	2	2	2	3	3	2	3	3	3	3	3
CO-2	3	3	3	3	3	3	3	3	3	3	3	3	3
CO-3	3	3	3	3	3	2	3	3	2	3	3	3	3
CO-4	3	3	3	3	3	3	2	3	3	3	3	3	3
CO-5	3	3	3	3	3	3	3	3	3	3	3	3	3
Average	3	3	2.8	2.8	2.8	2.8	2.8	2.8	2.8	3	3	3	

Digital Filter Design and Applications

COURSE CODE: 18B1WEC631

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Signals & Systems

Course Objectives:

1. To understand the basics and practical limitations of digital filter design.
2. To study the digital filters applications.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Understand the basics of the digital Filters	Familiarity
CO-2	Design and analysis of the FIR filters	Usage
CO-3	Design and analysis of the IIR filters	Usage
CO-4	Understand the limitation of IIR and FIR Filters in implementation	Familiarity
CO-5	Study the applications of digital filters	Assessment

Course Contents:

S. No.	Contents	Contact Hours
1.	Introduction to Filters: Butterworth filters, Chebyshev filters, Elliptical Filters, Bessel Filters, FIR filters, IIR Filters.	10
2.	FIR Filters: One dimensional FIR filter design using rectangular window, triangular window, hamming window, dolph-chebyshev window, and Kaiser window. Two dimensional FIR filter design.	10
3	IIR Filters: One dimensional and two dimensional IIR filter design.	06
4.	Practical Considerations in implementation Coefficient Quantization in Digital Filters, Scaling in Fixed-Point Arithmetic, Quantization Noise.	04
5.	Applications of Digital Filters, Noise suppression, Enhancement of selected frequency ranges, Removal or attenuation of selected frequencies, Bandwidth limiting. Analysis of digital filters for signal and image processing using MATLAB, and LABVIEW.	12
	Total	42

Suggested Text Book(s):

1. Andreas Antoniou, Digital Filters: Analysis, Design and Applications, Second edition, Tata Mc Graw Hill, 1999.
2. M. Ahmadi, M. Azimi-Sadjadi, R. Gorgui-Naguib, R. King, A. Kwabwe,Digital Filtering in One and Two Dimensions, 1st Edition, Springer Science & Business Media, 1989.

3. Jackson, Leland B. Digital Filters and Signal Processing: with MATLAB®Exercises. Springer Science & Business Media, 2013.

Suggested Reference Book(s):

1. Wu-Sheng Lu, Two-Dimensional Digital Filters, 1st Edition, CRC Press, 2001.
2. Winder, Steve, Analog and digital filter design, 2nd Edition, Newness Publishers, 2002
3. Schaumann, Rolf, Haiqiao Xiao, and Van V. Mac. "Design of Analog Filters 2nd Edition (The Oxford Series in Electrical and Computer Engineering)." (2009).
4. C. Britton Rorabaugh, "Digital Filter Designer's Handbook: With C++ Algorithms",2nd,Volume1, McGraw-Hill, 1997
5. Jolyon M.DeFreitas, Digital Filter Design and solutions, Artech house publishers, 2005
6. Andreas Antoniou, Digital Filters: Analysis, Design and Applications, Second edition, Tata Mc Graw Hill, 1999
7. Taylor, Fred. Digital filters: principles and applications with MATLAB. Vol. 30. John Wiley & Sons, 2011.

Other useful resource(s):

1. https://ocw.mit.edu/resources/res-6-008-digital-signal-processing-spring-2011/video-lectures/lecture-17-design-of-fir-digital-filters/, I Prof. Alan V. Oppenheim
2. http://web.stanford.edu/class/archive/ee/ee264/ee264.1072/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Digital Filter Design and Applications)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	3	2	2	1	1	1	1	3	1	1	1.8
CO-2	3	3	3	3	3	1	1	1	2	2	2	2	2.2
CO-3	3	3	3	3	3	1	1	1	2	2	2	3	2.3
CO-4	3	3	3	3	3	3	3	3	3	2	2	2	2.8
CO-5	3	3	3	3	3	3	3	3	3	2	2	1	2.7
Average	3	3	3	2.8	2.8	1.8	1.8	1.8	2.2	2.2	1.8	1.8	

Time-Frequency Analysis and Applications

COURSE CODE: 18B1WEC738

COURSE CREDITS: 3

CORE/ELECTIVE: Elective

L-T-P: 3-0-0

Pre-requisite: Signals and Systems

Course Objectives:

1. Study and analyze various spectral analysis and time-frequency analysis tools.
2. Study the time-frequency analysis tools based algorithm for different applications.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Understand the concept of the spectral analysis.	Familiarity
CO-2	Familiar with the basics concept of the short time Fourier transform /continuous wavelet transform.	Assessment
CO-3	Understand the basic concept of the distribution based Time-Frequency Analysis tools.	Assessment
CO-4	Develop the TFA based algorithms for various applications.	Usage

Course Contents:

Unit	Contents	Lectures required
1	Introduction to spectral analysis: Parametric and Non-Parametric methods.	6
2	Basics of Time Frequency Analysis: Basic Concepts & Definition, Duration-Bandwidth Principle, Joint Energy Density, Short-time FT, its Properties & Applications, MATLAB based implementation of STFT	6
3	Wavelet transforms: Continuous Wavelet Transform and its Computational aspects, Scale to Frequency conversion, Scalogram, Scaling Function and Wavelets, Applications of CWT, MATLAB based implementation of wavelet transform.	8
4	Distributions based time-frequency tools: Wigner-Ville Distributions, Interference in WVD, its Applications, Cohen's class, Smoothed WVD, Ambiguity Functions, Affine Class, and MATLAB based implementation of distribution based time-frequency analysis tools.	8
5	Case studies: Radar and Sonar, Economic Data Analysis with the Gabor Spectrogram, Gabor Spectrogram in Ultrasonic Nondestructive Materials testing, Applications of Time-Frequency Analysis in spectrum sensing, Biomedical signal processing, Genomics data analysis.	14
Total lectures		42

Suggested Text Book(s):

1. Hayes MH. Statistical digital signal processing and modeling. John Wiley & Sons; 2009.
2. Boashah B. Time-frequency signal analysis and processing: a comprehensive reference. Academic Press; 2015.

Suggested Reference Book(s):

1. S. Mallat, A Wavelet Tour of Signal Processing - The Sparse Way. Elsevier, Third Edition, 2009.
2. Cohen, Leon, Time-frequency analysis. Vol. 778. Prentice hall, 1995.
3. Chen, Victor C., and Hao Ling. Time-frequency transforms for radar imaging and signal analysis. Artech house, 2002.

Other useful resource(s):

1. http://nptel.ac.in/courses/117101001/: The lecture series on Wavelets and Multi-rate Digital Signal Processing created by Prof. Vikram M. Gadre in NPTEL.
2. Time-frequency toolbox (MATLAB) is available for download from http://tftb.nongnu.org/
3. http://nptel.ac.in/courses/117101001/1

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Time-Frequency Analysis and its Applications)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	3	2	2	2	1	1	1	1	3	3	3	2
CO-2	2	3	3	3	3	1	1	1	2	3	3	3	2.3
CO-3	3	3	3	3	3	1	1	1	2	3	3	3	2.4
CO-4	3	3	3	3	3	3	3	3	3	3	3	3	3
Average	2.5	3	2.75	2.75	2.75	1.5	1.5	1.5	2	3	3	3	

Wavelets and Applications

COURSE CODE:

COURSE CREDITS:

CORE/ELECTIVE: ELECTIVE

L-T-P: -3-0-0

Pre-requisite: Linear Algebra, Digital Signal Processing.

Course Objectives:

1. To introduce students to wavelet techniques and its types.
2. To enable students to apply wavelets in various engineering applications

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Understand the basics of wavelet transforms and compare it with Fourier transform.	Familiarity
CO-2	To construct various wavelet bases and know how to use them as a tool for analyzing functions.	Assessment
CO-3	Be familiar with multi-resolution analysis.	Familiarity
CO-4	Implement discrete wavelet transforms with multi-rate digital filters.	Assessment
CO-5	Design certain classes of wavelets to specification and justify the basis of the application of wavelet transforms to different fields.	Usage

Course Contents:

Unit	Contents	Lectures required
1	Introduction: Stationary and non-stationary signals, Signal representation using basis and frames, Brief introduction to Fourier transform and Short time Fourier transform, Time-frequency analysis, Bases of time frequency: orthogonal, Filter banks, Multi resolution formulation: Wavelets from filters, Classes of wavelets: Haar, Daubechies, bi-orthogonal.	7
2	Continuous Wavelet Transform: Continuous wavelet transform (CWT), Time and frequency resolution of the continuous wavelet transform, Construction of continuous wavelets: Spline, orthonormal, bi-orthonormal, Inverse continuous wavelet transform, Redundancy of CWT, Zoom property of the continuous wavelet transform, Filtering in continuous wavelet transform domain.	8
3	Discrete Wavelet Transform and Filter Banks: Orthogonal and biorthogonal two-channel filter banks, Design of two-channel filter banks, Tree-structured filter banks, Discrete wavelet transform, Non-linear approximation in the Wavelet domain, multi resolution analysis, Construction and Computation of the discrete wavelet transform, the redundant discrete wavelet transform	8

4	Multi Resolution Analysis: Multirate discrete time systems, Parameterization of discrete wavelets, Bi-orthogonal wavelet bases, Two dimensional, wavelet transforms and Extensions to higher dimensions, wave packets	7
5	Applications: Signal and Image compression, Detection of signal changes, analysis and classification of audio signals using CWT, Wavelet based signal de-noising and energy compaction, Wavelets in adaptive filtering, Adaptive wavelet techniques in signal acquisition, coding and lossy transmission, Digital Communication and Multicarrier Modulation, Trans multiplexers , Image fusion, Edge Detection and object isolation.	12
Total lectures		42

Suggested Text Book(s):

1. S. Mallat, "A Wavelet Tour of Signal Processing", 3rd Ed., Academic Press, Elsevier, Dec. 2008.
2. Raghuveer Rao and Ajit S. Bopardikar, "Wavelet transforms: Introduction, Theory and applications", Pearson Education Asia, 2000.

Suggested Reference Book(s):

1. J.C. Goswami and A. K. Chan, "Fundamentals of Wavelets: Theory, Algorithms, and Applications", 2nd ed., Wiley, 2011.
2. Michel Misiti, Yves Misiti, Georges Oppenheim, Jean Michel Poggi, "Wavelets and their Applications", John Wiley & Sons, 2010.

Other useful resource(s):

1. Link to NPTEL course contents: https://nptel.ac.in/courses/117/101/117101001/
2. MIT link: https://ocw.mit.edu/courses/mathematics/18-327-wavelets-filter-banks-and-applications-spring-2003/lecture-notes/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (1) - 5 Quizzes (2) - 15 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course Outcomes (Principles of Communication Systems)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	3	3	1	2	1	2	1	2	2	3	2.17
CO-2	3	3	3	3	3	2	2	2	1	1	1	3	2.25
CO-3	3	3	3	3	2	3	3	2	1	2	3	3	2.58
CO-4	3	3	3	2	2	1	1	1	1	2	3	3	2.08
CO-5	3	3	3	2	3	2	1	2	1	2	3	3	2.33
Average	3.00	3.00	3.00	2.60	2.20	2.00	1.60	1.80	1.00	1.80	2.40	3.00	

Adaptive Signal Processing and Machine Intelligence

COURSE CODE: XXXXXXXX

COURSE CREDITS: XX

CORE/ELECTIVE: XX

L-T-P: XX

Pre-requisite: Prerequisites are some prior knowledge to signals and systems, basics of digital signal processing and machine learning. Student should have a basic level of expertise in programming and mathematics.

Course Objectives:

1. To understand the fundamentals of statistical properties of complex-valued and multidimensional signals
2. Algorithms and applications of adaptive signal processing to real-time streaming data
3. Become familiar with learning algorithms for multidimensional signals
4. To study State of the Art machine learning algorithms in real time signal processing applications.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Gain in-depth understanding of adaptive signal processing algorithms	Familiarity
CO-2	Examine statistical properties and performance of these algorithms in real-world applications.	Assessment
CO-3	Apply adaptive learning algorithms for multidimensional signals	Assessment
CO-4	Study of real world case studies and applications	Usage

Course Contents:

Unit	Contents	Lectures required
1	Introduction: Review of orthogonal transforms: DFT, DCT and Haar, Properties of DFT, Computation of DFT: FFT and structures, Decimation in time, Decimation in frequency, Linear convolution using DFT, Basic FIR/IIR filter structures, FIR/IIR Cascaded lattice structures, Parallel all pass realization of IIR transfer functions, Computational complexity of filter structures	8
2	Basics of Adaptive Signal Processing: Linear algebra and random processes, Optimal estimation, Linear estimation. Steepest-descent algorithms. Stochastic-gradient algorithms. Kalman filtering. Particle filtering. Blind de-convolution and beam forming, Robust adaptive filters, Adaptive filters, Least Mean Squares algorithm	8
3	Machine Learning for Signal Processing: Distance based signal classification, nearest neighbor classifier, Hilbert space, Linear systems,	7

	circulant matrices, convolution, eigenvector decomposition using SVD, Bayes classifiers based signal detection, dimensionality reduction using PCA	
4	Kernel based Machine Learning for Signal Processing: Review of support vector machine (SVM), Classification and Regression using SVM, Properties of Kernels, Non-Mercer Kernels, Kernel Selection, Multiple Kernel Learning, Kernel features	7
5	Deep Neural Network for Signal Processing: Nonlinear learning algorithms and architectures, such as dynamical perceptrons, feedforward and recurrent neural networks, and their connection with general neural networks and deep learning. Tensors for Big Data applications	6
6	Applications in Real World Domain: Transfer Learning, Dictionary learning, Attention models, Attribute-based learning, Deep learning for wireless applications, speech and image processing, sparse signal processing and compressive sensing for machine learning.	6
Total lectures		42

Suggested Reference Book(s):

1. C.M. Bishop, "Pattern Recognition and Machine Learning", 2nd Edition, Springer, 2011.
2. D. Yu and L. Deng, "Automatic Speech Recognition: A Deep Learning Approach" , Springer, 2016.
3. I. Goodfellow, Y, Bengio, A. Courville, "Deep Learning", , MIT Press, 2016.

Other useful resource(s):

1. http://home.iitk.ac.in/~vipular/stuff/2019_MLSP.html
2. http://web.stanford.edu/class/ee269/index.html
3. http://intranet.ee.ic.ac.uk/electricalengineering/eecourses_t4/course_content.asp?c=EE4-13&s=D4

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Adaptive Signal Processing and Machine Intelligence)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	3	3	2	1	1	1	2	2	2	2	1.91
CO-2	3	3	3	3	3	2	1	1	3	2	1	3	2.33
CO-3	2	3	2	2	2	2	2	2	2	2	1	2	2.00
CO-4	3	3	3	3	2	1	1	1	2	3	2	3	2.25
Average	2.50	2.75	2.75	2.75	2.25	1.50	1.25	1.25	2.25	2.25	1.50	2.50	

Bio Electronics Sensors

COURSE CODE:

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Analog Electronics

Course Objectives:

1. To study transducers and sensors (bio sensors)
2. to study bio-potentials, bio-electrodes and bio-signal amplifiers

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Gain knowledge on sensors, actuators and transducers	Familiarity
CO-2	Learn to design circuits of bio-sensor for electrical and nonelectrical signals	Usage
CO-3	Acquaint with different types of amplifiers used for biosensors	Familiarity
CO-4	Learn about bio-potential and bio-potential amplifiers	Assessment

Course Contents:

Unit	Contents	Lectures required
1	Introduction: Introduction to Sensor, Bio electronics, Bioelectronics Sensor, Systems biology and Synthetic biology	4
2	Electrodes, Sensors and transducers: Sensor/Actuators, Active v/s passive sensors, sensor error sources, sensor terminology, Types of Sensors, Bio sensor, Block diagram of Bio-sensor for electrical and non electrical signals, electrodes for biophysical sensing, transducers, performance parameters of sensors, complete circuit diagram of bio sensor.	8
3	Bio-potential Electrodes: The electrode-electrolyte interface, polarization, polarizable and non-polarizable electrodes, Electrode behavior and circuit models, body surface recording electrodes, internal electrodes, micro electrode, macro electrode	4
4	Bio-electric Amplifiers: Voltage, current, power amplifiers, Low gain, medium gain, high gain amplifiers	6
5	Bio-potentials: ECG, EEG, EMG, ERG, EOG, its amplitude and bandwidth, Electrodes for Bio-potential Recordings, Electrical Interference Reduction.	6
6	Bio-potential Amplifiers: Operational amplifiers, basic amplifier configurations, multiple input circuits, differential amplifiers, signal processing circuits, isolation amplifiers, IMRR, ECG Amplifier, functional block, interference from electric devices, transient protection, common mode and other interference reduction circuits, Driven right leg circuit, amplifiers	8

	for other bio-potential signals, pre amplifier.	
7	Bio-signal Amplifiers : Instrumentation amplifier, Chopper Amplifier, Carrier Amplifier	6
Total lectures		42

Suggested Text Book(s):

1. Carr, J. J., Brown, J. .M., "Introduction to Biomedical Equipment Technology," 4th Ed, Pearson, 2001.
2. Reddy, D. D., Hussian, O.M., Gopal, D.V. R., Rao, D. M., Sastry, K.S. "Biosensors and Bioelectronics," I.K. International Pub., 2012
3. Gayakwad, R. A., "Op-amps and Linear Integarted Circuits," 4th Ed., PHI, 2000.
4. Klir, G. J., Yuan, B, "Fuzzy Sets and Fuzzy Logic," PHI. Pearson, 1995.

Suggested Reference Book(s):

1. Webster JG (Ed.), "Medical Instrumentation, Application and Design," 4th Ed., John Wiley & Sons, 2016.
2. Chatterjee S and Miller A, "Biomedical Instrumentation Systems," Cengage Learning, 2018

Other useful resource(s):

1. NPTEL ONLINE COURSES NPTEL: Biomedical Signal Processing
   https://nptel.ac.in/courses/108105101/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course Outcomes (Bio Electronics Sensors)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO1	3	3	2	1	1	2	X	X	X	X	X	2	1.17
CO2	3	3	3	2	2	2	X	X	1	2	2	3	1.92
CO3	3	3	2	1	1	2	X	X	X	1	1	3	1.42
CO4	3	3	2	2	1	2	X	X	X	1	1	3	1.50
Average	3.00	3.00	2.25	1.50	1.25	2.00	0.00	0.00	0.25	1.00	1.00	2.75	

Fundamentals of Digital Image Processing and Applications

COURSE CODE: 20B1WEC533

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite:

Course Objectives:

1. Describe and explain basic principles of digital imageprocessing.
2. Design and implement algorithms that perform basic image processing.
3. Design and implement algorithms for advanced image analysis.
4. Assess the performance of image processing algorithms andsystems.

Course Outcomes

This course provides the knowledge of analog and digital communication system analysis and design. After study through lectures and assignments, students will be able to

S. No.	Course Outcomes	Level of Attainment
CO-1	Analyze general terminology of digital image processing.	Familiarity
CO-2	Examine various types of images, intensity transformations and spatial filtering.	Usage
CO-3	Evaluate the methodologies for image segmentation, restoration etc.	Usage
CO-4	Understand different types of medical imaging modalities and would be able to differentiate them with respect to their advantages and limitations.	Usage

Course Contents:

Unit	Contents	Lectures required
1	Digital Image Fundamentals: Fundamental steps in DIP, Components of digital image processing, elements of visual perception, Structure of the human eye, Image formation in the eye, Brightness adaptation and discrimination, light, Image sensing and acquisition, image formation model, definition and some properties of two dimensional system, Discrete 2D convolution, 2D discrete Fourier transform and its properties, optical and modulation transfer function, Spectral density function. Sampling and quantization of images, Two dimensional sampling theory, representation of digital image, Spatial and gray level resolution, zooming and shrinking, some basic relationships between pixels.	7

2	Image Enhancement in the Spatial Domain: Gray Level Transformations, Piecewise linear transformation, Histogram Processing, Enhancement Using Arithmetic/Logic Operations. Basics of Spatial Filtering, Smoothing and Sharpening Spatial Filters, Use of first order and second order derivative in enhancement.	7
3	Image Enhancement in the Frequency Domain: Two dimensional Fourier Transform, properties of frequency domain, correspondence between filtering in spatial and frequency domain, Smoothing and Sharpening frequency domain filters, Homomorphic Filtering.	7
4	Image Restoration: Model of the Image Degradation/Restoration Process, Noise Models, Noise reduction in spatial domain and frequency domain, Inverse filtering, Wiener filtering.	7
5	Image Segmentation: Detection of Discontinuities (point, line edge), Edge Linking and Boundary Detection, Thresholding, Basic global Thresholding, Adaptive Thresholding, Region-Based Segmentation, region growing, splitting and merging.	7
6	Application of Image Processing In Medical Field: Working principle, applications and limitations of different medical imaging modalities. Types of texture parameters: Statistical analysis of texture (First order statistics and Second order statistics), Grey level co-occurrence matrix, grey-level run length matrix.	7
Total lectures		42

Text Books

1. R.C.Gonzalas and R.E.Woods, Digital Image Processing, Prentice Hall, 3rd Ed.
2. Rangaraj M. Rangayyan: Biomedical Image Analysis, 1st Ed., CRC Press, New York , 2004.

Reference Books

1. A.K.Jain, Fundamentals of Digital Image Processing, PrenticeHall.
2. S.Sridhar, Digital Image Processing, Oxford UniversityPress.

EvaluationScheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus

4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes(2) -10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Fundamentals of Digital Image Processing & Applications)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	3	3	3	3	2	3	1	2	1	2	2.42
CO-2	3	3	3	3	2	0	0	1	2	3	1	1	1.83
CO-3	3	3	3	3	3	1	1	1	1	2	1	1	1.92
CO-4	3	3	3	3	3	3	2	3	2	2	3	3	2.75
Average	3.00	3.00	3.00	3.00	2.75	1.75	1.25	2.00	1.50	2.25	1.50	1.75	

Computer Vision

COURSE CODE: XXXXXXXX

COURSE CREDITS: XX

CORE/ELECTIVE: XX

L-T-P: XX

Pre-requisite: Prerequisites are some prior knowledge to computer vision, machine learning and image processing. Student should have a basic level of expertise in programming, computer science, and mathematics.

Course Objectives:

1. To implement fundamental image processing techniques required for computer vision.
2. Understand image formation process.
3. Extract features form Images and generate 3D model from images.
4. To study State of the Art algorithms with engineering applications.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Theoretical and practical aspects of computing with images	Familiarity
CO-2	The foundation of image formation and image analysis	Assessment
CO-3	Understand the basics of 2D and 3D Computer Vision	Assessment
CO-4	Study of computer vision applications	Usage

Course Contents:

Unit	Contents	Lectures required
1	Introduction : Image Processing, Computer Vision and Computer Graphics Overview of Diverse Computer Vision Applications: Document Image Analysis, Biometrics, Object Recognition, Tracking, Medical Image Analysis, Content-Based Image Retrieval, Video Data Processing, Multimedia, Virtual Reality and Augmented Reality	8
2	Image Formation Models : The 'Physics' of Image Formation, Radiance, Irradiance, BRDF, color etc, Camera model and Camera calibration, Binocular imaging systems, Multiple views geometry, Structure determination, shape from shading, Photometric Stereo, Depth from Defocus, Construction of 3D model from images	8
3	Feature Extraction and Motion Estimation: Image preprocessing, Image representations (continuous and discrete), Edge detection, Regularization theory, Stereo Vision, Motion estimation, Structure from motion	7

4	Shape Representation and Segmentation : Contour based representation, Region based representation, Deformable curves and surfaces, Snakes and active contours, Level set representations, Fourier and wavelet descriptors, Multi resolution analysis	7
5	Object recognition: Hough transforms and other simple object recognition methods, Shape correspondence and shape matching, Principal component analysis, Singular value decomposition.	6
6	Applications: Face detection, Face recognition, Eigen faces, Active appearance and 3D shape models of faces Application, Applications range from Biometrics, Medical diagnosis, document processing, mining of visual content, to surveillance, advanced rendering etc.	6
Total lectures		42

Suggested Text Book(s):

1. D. Forsyth and J. Ponce, "Computer Vision - A modern approach, by ", Prentice Hall
2. B. K. P. Horn, "Robot Vision", McGraw-Hill.
3. R. C. Gonzalez, R. E. Woods, " Digital Image Processing" Addison Wesley Longman, Inc., 1992
4. D. H. Ballard, C. M. Brown, "Computer Vision", Prentice-Hall, Englewood Cliffs, 1982.

Suggested Reference Book(s):

1. Simon J. D. Prince, "Computer Vision: Models, Learning, and Inference", Cambridge University Press, 2012
2. Mark Nixon and Alberto S. Aquado, "Feature Extraction & Image Processing for Computer Vision", Third Edition, Academic Press, 2012.

Other useful resource(s):

1. Computer Vision. Ballard and Brown
2. Invitation to 3D Vision: From Images to Geometric Models: Y. Ma, S. Soatto, J. Kosecka and S. Sastry
3. https://nptel.ac.in/noc/courses/noc19/SEM2/noc19-cs58/
4. https://www.tutorialspoint.com/dip/computer_vision_and_graphics.htm

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Computer Vision)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	3	3	2	1	1	1	2	2	2	2	1.91
CO-2	3	3	3	3	3	2	1	1	3	2	1	3	2.33
CO-3	2	3	2	2	2	2	2	2	2	2	1	2	2.00
CO-4	3	3	3	3	2	1	1	1	2	3	2	3	2.25
Average	2.50	2.75	2.75	2.75	2.25	1.50	1.25	1.25	2.25	2.25	1.50	2.50	

Forensic Image Processing

COURSE CODE:

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Prerequisite: Fundamentals of Digital Image Processing

Course Objectives:

1. To aware the students about the role of image processing for forensic investigations.
2. To introduce different attributes of the image source that helps in the identification of the source of the image.
3. To make students understand the role of watermarking, cryptography and other methods used for forensic investigation.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Understand the requirement of image processing in Image processing	Familiarity
CO-2	Understand the working of digital image capturing devices and parameters related to the devices.	Usage
CO-3	Understand the attributes of the image source for forensic investigation.	Usage
CO-4	Able to implement watermarking and cryptography methods on images.	Assessment
CO-5	Able to compare the two images and identify the content present in them.	Assessment

Course Contents:

Unit	Contents	Lectures required
1	Forensic image analysis: A Framework and its applications (Example of Police cases solved with forensic image processing)	3
2	Digital Still and Video Cameras: Dynamic Range, Light and Lenses, Setting exposure, Resolution, File format and compressions, JPEG and MPEG compression	7
3	Image Enhancement and Restoration: Color Spaces, Color Correction, Interpolation, Convolutions, Enhancement Filters, Morphological Filters, Sharpening Contrast	8
4	Techniques attributing an image to its source: Image and Video source class identification, Sensor defects in digital image forensic	8
5	Detecting doctored images: Digital Watermarking and cryptography	8

6	Photo Image Comparison, Image Content Analysis, Image Authentication	8
Total lectures		42

Suggested Text Book(s):

1. Sencar, Husrev Taha, Memon, Nasir (Eds.), "Digital Image Forensics: There is More to a Picture than Meets the Eye", Springer, 2012.

Suggested Reference Book(s):

1. Anthony T. S. Ho, Shujun Li, "Handbook of Digital Forensics of Multimedia Data and Devices", Wiley 2016.
2. Ahmed Bouridane, "Imaging for Forensics and Security", Springer, 2009

Other useful resource(s):

1. Judith A. Redi, Wiem Taktak & Jean-Luc Dugelay, "Digital image forensics: a booklet for beginners", Multimedia Tools and Applications volume 51, pages133–162, 2011.
2. NPTEL online course: https://www.youtube.com/watch?v=O2RwWHWHQlM

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered up to T-1
2	T-2	25	1.5 Hours	Syllabus covered up to T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Average
CO1	2	3	2	2	2	2	2	x	x	2	2	2	2.1
CO2	2	3	2	2	2	2	2	x	x	2	2	2	2.1
CO3	3	3	3	3	3	2	2	x	3	2	2	2	2.54
CO4	3	3	3	3	3	2	2	x	3	2	2	2	2.54
CO5	3	3	3	3	3	2	2	x	3	2	2	2	2.54
Average	2.6	3	2.6	2.6	2.6	2	2	x	3	2	2	2	

Medical Image Processing

COURSE CODE: 18B1WEC836

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

1. To introduce various medical imaging modalities.
2. To teach the requirement and development of different blocks of computer aided diagnosis for medical images.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Able to understand different types of medical imaging modalities and would be able to differentiate them with respect to their advantages and limitations.	Familiarity
CO-2	Acquire an ability to analyze and process medical images.	Usage
CO-3	Understand different feature extraction techniques and classifiers used for image classification.	Usage
CO-4	Understand the role of computer aided diagnosis for medical images.	Assessment

Course Contents:

Unit	Contents	Lectures required
1	Introduction to Image Processing:- Acquisition of Images, Image Sampling and quantization; Spatial and histogram based enhancement; Noise modeling, Image restoration. Image transformation.	8
2	Edge Detection and Image Segmentation: Gradient based edge detectors. Intensity thresholding based image segmentation; Region growing and region splitting algorithm; watershed segmentation.	8
3	Medical Imaging Modalities: Working principle, applications and limitations of Computed tomography , X-ray, Magnetic resonance imaging, Ultrasound imaging, and Positron emission tomography; Various Artifacts.	6
4	Image Texture: Types of texture parameters: Statistical analysis of texture (First order statistics and Second order statistics), Grey level co-occurrence matrix, grey-level run length matrix.	8
5	Pattern classification: Supervised and Unsupervised pattern classification, Neural Network classifier, Support Vector Machines.	6

6	Case Studies: Pre-processing, Segmentation, Feature extraction, and Classification of medical images.	6
Total lectures		42

Suggested Text Book(s):

1. Chris Solomon, Toby Breckon: Fundamental of Digital Image Processing, 1st Ed., John Wiley & Sons, 2011.
2. Rangaraj M. Rangayyan: Biomedical Image Analysis, 1st Ed., CRC Press, New York , 2004.

Suggested Reference Book(s):

1. RC Gonzalez, RE Woods, Digital Image Processing, 3rd Ed., Pearson Publisher, 2008.
2. Kayvan Najarian, Robert Splinter: Biomedical Signal and Image Processing, 2nd Ed., CRC Press, 2012
3. Tamal Bose: Digital Signal and Image Processing, 1st Ed., John Wiley & Sons, 2003.

Other useful resource(s):

1. http://www.nptelvideos.in/2012/12/digital-image-processing.html (Prof P.K. Biswas, IIT Kharagpur)

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes(2) -10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Medical Image Processing)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	3	3	3	3	2	3	1	2	1	2	2.42
CO-2	3	3	3	3	2	0	0	1	2	3	1	1	1.83
CO-3	3	3	3	3	3	1	1	1	1	2	1	1	1.92
CO-4	3	3	3	3	3	3	2	3	2	2	3	3	2.75
Average	3.00	3.00	3.00	3.00	2.75	1.75	1.25	2.00	1.50	2.25	1.50	1.75	

Applied Medical Signal Processing

COURSE CODE:

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

1. To introduce different biomedical signals.
2. To apply different methods to analyze and filter the signals.
3. To detect events in signals used for diagnosis.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Identify and reproduce signal processing methods used in forefront biomedical sciences	Familiarity
CO-2	Able to filter out the noise and artifacts from the medical signals.	Usage
CO-3	Critically assess the appropriateness of biomedical signal processing techniques for various problems in the field	Usage
CO-4	Evaluate the effectiveness of techniques applied to biomedical signals against specific benchmarks	Assessment

Course Contents:

Unit	Contents	Lectures required
1	Introduction: Preliminaries, Medical signal origin & dynamics (ECG, EEG, EMG etc.)	4
2	Filtering for removal of artifacts: Statistical Preliminaries, Time domain filtering (Synchronized Averaging, Moving Average, Derivative-based operator), Frequency Domain Filtering (Notch Filter), the Weiner Filter, Adaptive Filter and related design problems.	12
3	Waveform Analysis: Illustrations of problem with case studies, Morphological analysis, transform analysis, correlation coefficient, Periodogram, Averaged periodogram, Blackman-Tukey Spectral Estimator, Daniell's Spectral Estimator, Measures derived from PSD	9
4	Modeling of Biomedical Systems: Motor unit firing pattern, Autoregressive model, Autocorrelation method, Parametric modeling, Levinson-Durbin algorithm, Covariance method, Spectral matching and parameterization, Model order selection	12

5	Pattern classification and diagnostic decision: Illustrations of problem with case studies, Feature extractions from medical signals, supervised and unsupervised pattern classification, Reliability of features, classifiers and decisions.	5
Total lectures		42

Suggested Text Book(s):

1. Rangaraj M. Rangayyan, Biomedical Signal Analysis, 2nd Ed., Wiley, 2015.
2. Willis J. Tompkins , Biomedical Digital Signal Processing, 10th Ed., Prentice Hall, 2011
3. D C Reddy, Biomedical Signal Processing: Principles and Techniques, 1st Ed., Tata McGraw-Hill Publishing Co. Ltd, 2005
4. J G Webster, Medical Instrumentation: Application & Design, 3rd Ed. John Wiley & Sons Inc., 2007

Suggested Reference Book(s):

1. R. S Khandpur and Raghbir Khandpur: Biomedical Instrumentation, 2nd Ed., McGraw-Hill Education , 2003.
2. Leslie Cromwell, Fred Weibell J, Erich Pfeiffer. A: Biomedical Instrumentation and Measurements, Prentice-Hall India, 2nd Edition, 1997.
3. C Raja Rao, S K Guha, Principles of Medical Electronics and Biomedical Instrumentation, 1st Ed., Universities Press, 2001

Other useful resource(s):

Link to NPTEL course contents:

1. https://nptel.ac.in/courses/108105101/
2. https://onlinecourses.nptel.ac.in/noc19_ee23/preview

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes(2) -10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Applied Medical Signal Processing)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	1	3	2	3	2	2	3	2	2	1	3	2.28
CO-2	3	3	3	3	3	1	1	2	2	2	1	3	2.25
CO-3	3	3	3	3	3	1	1	2	2	2	1	3	2.25
CO-4	3	3	3	3	3	1	1	2	2	2	1	3	2.25
Average	2.75	2.5	3	2.75	3	1.25	1.25	1.25	2	2	1	3	

Remote Sensing and Satellite Image Processing

COURSE CODE:

COURSE CREDITS: 3

CORE/ELECTIVE: Elective

L-T-P: 3-0-0

Pre-requisite: None.

Course Objectives: To provide basic understanding about satellite based Remote Sensing and analyses Satellite Image Processing techniques.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	To lay foundations in understanding the concepts of remote sensing.	Familiarity
CO-2	To lay foundations in analyzing the images obtained from satellites	Usage
CO-3	To apply the theoretical knowledge acquired to various applications.	Usage
CO-4	To understand about different imaging techniques and their applications	Familiarity and Usage

Course Contents:

S. No	Topics	Classes
1	Remote Sensing: Basics of Remote Sensing: Overview of Remote sensing: Definition of Remote sensing, Principles of Remote Sensing, Electromagnetic Radiation, Radiometric terms and definitions, Radiation Laws, EM spectrum, Sources of EM, Interaction of EM Radiation with atmosphere, and target, Atmospheric Widows, imaging spectrometry, Spectral signature of various land cove features Platforms and sensors: Platforms: Types of platforms, ground, airborne, and space born platforms, Orbit of satellites, Kepler's Law, satellite characteristics, satellites for Earth observations studies, and planetary missions (Chandrayana) Sensors: Types and classification of sensors, imaging modes, Characteristics of optical sensors, sensor resolution-spectral, radiometric and temporal, Characteristics of detectors.	8
2	Data reception, Data processing & Data generation: Ground station, Data generation, Data processing & correction, Radiometric and Geometric corrections, Radiometric corrections, Random noise correction, Atmospheric correction, Geometric errors and corrections, Distortion evaluated from tracking data, distortion evaluated from ground control Image correction. Ground Investigation in support of Remote sensing, Uses of ground data, calibration correction, Interpretation of properties, Training sets, Accuracy evaluation, test	8

	sites, Ground truth Instruments and spectral signature, Spectral Reflectance and spectral signature of vegetation, Sources of RS data: Global and Indian data products	
3	Visual Image Interpretation: Introduction to Visual Interpretation, Basic principles of Visual Interpretation, Elements of Visual Interpretation, Techniques of Visual Interpretation, Interpretation Keys, Methods of searching and sequence of Interpretation, Methods of analysis and Reference levels, Computer compatible tapes – Band sequential format, Band interleaved by Line format, Run-length encoding format. Hardcopy outputs – Generation of B/W and False Color Composites. Generally supported scales of the data products, Information about annotation of the products.	9
4	Thermal Imaging system: Thermal Imaging System: Introduction - IR region of the Electromagnetic spectrum, Atmospheric transmission, Kinetic and radiant temperature, Thermal properties of materials, Emissivity, Radiant temperature. Thermal conductivity. Thermal capacity, thermal inertia, apparent thermal inertia, Thermal diffusivity. Radiation principles (Plank's Law, Stephen Boltzman law), Interaction of EMR with earth surface, Wien's displacement law, Kirchoffs Law).IR - radiometers, Airborne and Satellite TTR scanner system Characteristics of IR images, Scanner distortion, image irregularities, Film density and recorded ,Temperature ranges, Effects of weather on images, Clouds, Surface winds, Penetration of smoke plumes, Interpretation of thermal imagery, Advantages of Thermal imagery	9
5	Microwave Remote Sensing: Introduction - Electromagnetic spectrum, Airborne and Space borne radar systems basis instrumentation. System parameters - Wave length, Polarization, Resolutions, Radar geometry. Target parameters - Back scattering, Point target, Volume scattering, Penetration, Reflection, Bragg resonance, Cross swath variation. Speckle radiometric calibration. Microwave sensors and Image characteristics, Microwave image interpretation, Application : Geology, Forestry, Land use, Soils etc. Future trends and Research, Physics of lager, laser interaction with objects. Types of LiDAR, platforms of LiDAR, components of LiDAR.	8

Suggested Text Book(s):

1. Sabins Jr, Floyd F. *Remote sensing--principles and interpretation*. WH Freeman and company, 1987.
2. Lillesand, Thomas, Ralph W. Kiefer, and Jonathan Chipman. *Remote sensing and image interpretation*. John Wiley & Sons, 2015.
3. Davis, Shirley M., et al. "Remote sensing: the quantitative approach." *mhi* (1978).
4. Jensen, John R. *Introductory digital image processing: a remote sensing perspective*. No. Ed. 2. Prentice-Hall Inc., 1996.
5. Trevett, J. William. *Imaging radar for resources surveys*. Springer Science & Business Media, 2013.

Suggested Reference Book(s):

1. Mather, Paul M., and Magaly Koch. *Computer processing of remotely-sensed images: an introduction*. John Wiley & Sons, 2011.
2. Schowengerdt, Robert A. *Remote sensing: models and methods for image processing*. Elsevier, 2006.

Other useful resource(s):

1. Link to NPTEL course contents: https://nptel.ac.in/courses/105/108/105108077/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Optimization Techniques)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	2	1	1	1	2	1	2	1.7
CO-2	2	3	2	3	2	2	1	1	1	2	1	2	1.8
CO-3	3	3	3	3	3	2	1	1	1	2	1	2	2.1
CO-4	2	2	2	2	2	2	1	1	1	3	1	2	1.8
Average	2.25	2.5	2.25	2.5	2.25	2.0	1.0	1.0	1.0	2.25	1.0	2.0	

RF Integrated Circuits

COURSE CODE:

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives: This course will develop electronic circuits for radio frequency applications, specific to CMOS integrated circuits

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Introduction to CMOS integrated circuits specific to radio frequencies.	Familiarity
CO-2	Design of circuits for radio frontends for mobile phone handsets.	Usage
CO-3	Learn to design low noise amplifiers and mixer circuits.	Usage
CO-4	Applications of voltage controlled oscillators and phase locked loops, power amplifier in the design of modern radio architecture.	Assessment

Course Contents:

Unit	Contents	Lectures required
1.	Introduction:RF systems-basic architectures, Transmission media and reflections, Maximum power transfer, Passive RLC Networks:Parallel RLC tank, Series RLC networks, matching, Pi match, T match, MOS device review	6
2.	Passive IC components: Resistors, capacitors, inductors, wires and transmission lines	6
3.	High Frequency Amplifier Design: Bandwidth estimation using open-circuit time constants, Bandwidth estimation using short-circuit time constants, Rise time, delay and bandwidth, Zeros to enhance bandwidth, Shunt-series amplifiers, tuned amplifiers, Cascaded amplifiers. Noise: Thermal noise, flicker noise review, Noise figure, phase noise general consideration	7
4.	Low noise amplifiers and Mixer design: Intrinsic MOS noise parameters, Power match versus noise match, Large signal performance, Multiplier based mixers, multiplier fundamentals, Subsampling mixers	6
5.	Voltage controlled oscillator: A tank based oscillators, phase in oscillators, Resonators, Negative resistance oscillators,	5

6.	Phase locked loops:Phase locked loop basics, charge pump, PLL dynamics integer, Spurious frequencies fractional and synthesis, Fractional spurs, Delta and sigma modulation	6
7.	RF Power Amplifiers: Class abc power amplifiers, Class bcd power amplifiers and Class cd pwm amplifiers	6
Total lectures		42

Suggested Text Book(s):

1. T. H. Lee, “The Design of CMOS Radio-Frequency Integrated Circuits”, Cambridge University Press, 2004.
2. B. Razavi, “RF Microelectronics”, Prentice Hall, 1997
3. B. Christopher, “RF circuit design”, Elsevier, 2011

Other useful resource(s):

1. NPTEL online course: https://nptel.ac.in/courses/117/102/117102012

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes(2) -10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course Outcomes (RF Integrated Circuits)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO1	2	1	3	3	3	2	1	1	1	1	1	1	1.67
CO2	3	3	3	2	2	2	1	1	3	3	2	3	2.33
CO3	3	3	3	3	2	2	1	1	3	2	2	3	2.33
CO4	3	3	3	3	2	2	1	1	3	2	2	2	2.25
Average	2.75	2.50	3.00	2.75	2.25	2.00	1.00	1.00	2.50	2.00	1.75	2.25	

Fundamentals of Computational Electromagnetics

COURSE CODE:

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

Computational techniques are used for practical applications in electromagnetic fields, devices, scattering, propagation, and radiation. Techniques like method of moments, finite difference method, finite element method, physical optics, and hybrid methods form the background of various electromagnetic solvers.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Student will be able to identify the best numerical method to simulate a given device.	Familiarity
CO-2	Students will be able to solve scattering problems and antenna radiation/impedance calculation problems	Usage
CO-3	The student will be able to formulate and implement the finite-difference method.	Usage
CO-4	The student will be able to formulate and implement finite volume method.	Assessment

Course Contents:

Unit	Contents	Lectures required
1.	Introduction: Introduction to transmission lines, uniform plane waves, plane waves at Media interface, Microwave waveguide: Rectangular waveguide and circular waveguide.	9
2.	FDM - Finite Difference Method: Background, Finite differencing, Accuracy, Dispersion, Stability, Maxwell PDE System, Maxwell FDTD System, Maxwell FDFD System, Boundary conditions: Introduction Absorbing Boundary Conditions (ABCs).	9
3.	Variational Method: Background, Calculus of Variations, variational methods: Rayleigh-Ritz Method, Method of weighted residuals, Galerkin Method	6
4.	FEM-Finite Element Method: Background, FEM from Weighted Residuals, Formulation (Basis Function, Mapping), Poisson Equation, Time Domain FEM (FETD)	7
5.	MOM- Method of Moments: Galerkin Method Integral Equation, Lorenz Gauge Integral Equation to Matrix Form, Wave equation using potentials, Green Function, Thin Wire Approximation, Magnetic Vector Potential, Incident and radiated field, Pulse basis function.	7

6.	FVM- Finite Volume Method: Motivation and Background Derivation of Eigen value Equation, Discretization Maxwell Equation, Flux function.	4
Total lectures		42

Suggested Text Book(s):

1. A. Bondeson, T. Rylander, and P. Ingelstom, "Computational Electromagnetics", Springers, 2005
2. A. C. Ballanis, "Antenna theory analysis and design", John Willey and Son's Inc., New York, 2005

Suggested Reference Book(s):

1. R. E. Colin. "Foundations for Microwave Engineering" McGraw Hill, 2nd Edition, 2001
2. E. C. Jordan and K. G. Balmain, "Electromagnetic Waves and Radiating Systems" Prentice Hall. Englewood Cliffs, New Jersey, 1998
3. S. Y. Liao, " Microwave solid-state devices", Prentice Hall, 1985
4. D. M. Pozar, "Microwave engineering", John Wiley & Sons, 2009

Other useful resource(s):

1. NPTEL online course: https://nptel.ac.in/courses/108/101/108101090

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered up to T-1
2	T-2	25	1.5 Hours	Syllabus covered up to T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

CO/PO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO1	2	1	3	3	3	2	1	1	1	1	1	1	1.67
CO2	3	3	3	2	2	2	1	1	3	3	2	3	2.33
CO3	3	3	3	3	2	2	1	1	3	2	2	3	2.33
CO4	3	3	3	3	2	2	1	1	3	2	2	2	2.25
Average	2.75	2.50	3.00	2.75	2.25	2.00	1.00	1.00	2.50	2.00	1.75	2.25	

Microwave Theory and Techniques

COURSE CODE: 18B1WEC731

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Basics of Electromagnetic Engineering

Course Objectives:

2. To learn the basic principles of microwave generators and amplifiers.
3. To have foundations on microwave design principles and measurement.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	To identify different microwave components and their applications.	Familiarity
CO-2	To study the performance of specialized microwave tubes such as klystrons.	Familiarity
CO-3	To understand the principle of operation of magnetrons, traveling wave tubes and BWOs.	Assessment
CO-4	To understand the working principle of microwave solid state devices and their applications.	Assessment
CO-5	To design of microwave filters, amplifiers and oscillators.	Usage
CO-6	To learn about microwave power, VSWR, impedance and attenuation measurements.	Usage

Course Contents:

Unit	Contents	Lectures required
1	Introduction: Introduction to microwaves, Scattering matrix of microwave waveguide junction, properties of S-matrix, E-plane tee, H-plane tee, magic tee, attenuators, directional couplers, ferrite devices, Faraday rotation, gyrator, isolator, circulators and cavity resonators.	8
2	Microwave Tubes: Limitations and losses of conventional tubes at microwave frequencies, microwave tubes-O-type and M-type classifications. O-type tubes: Two cavity klystron-structure, reentrant cavities, velocity modulation process and apple gate diagram, bunching process and small signal theory- expression for output power and efficiency. Reflex Klystron-Structure, velocity modulation and apple gate diagram, mathematical theory of bunching, power output, efficiency, oscillating modes and output characteristics.	9

3	Microwave Crossed-Filed Tubes: M-Type tubes: Introduction, cross filed effects, magnetrons-different types, cylindrical travelling wave magnetron-Hull cut-off and Hartree conditions, mode of resonance and PI-mode of operations, separation of PI-mode, output characteristics, Backward wave crossed field oscillator (Carcinotron).	6
4	Helix TWTs: Significance, types and characteristics of slow wave structures, structure of TWT and amplification process (qualitative treatment), suppression of oscillations, gain considerations.	5
5	Microwave Solid state Devices: Introduction, classification, applications. TEDs-Introduction, Gunn diodes-principle, RWH theory, characteristics, modes of operations, IMPATT diode, TRAPATT Diode, BARITT diode, PIN diode, Tunnel diode.	7
6	Microwave Design Principles and Measurements: Microwave Filter Design, Microwave Amplifier Design, Low Noise Amplifier Design, Microwave Oscillator Design, VSWR and impedance measurement, attenuation measurement and power measurement.	7
Total lectures		42

Suggested Text Book(s):

1. Samuel Y.Liao, " Microwave Devices and Circuits", 3rd Edition, Pearson education, 2003.
2. R.E.Collin, "Foundations for microwave Engineering", 2nd Edition, Tata Mc Graw Hill, 1992.
3. Pozar, David M. "Microwave engineering", 4th Edition, John Wiley & Sons, 2013.

Suggested Reference Book(s):

1. Annapurna Das, Sisir.K.Das, "Microwave Engineering",1st Edition, Tata McGraw Hill, 2000.

Other useful resource(s):

1. Link to topics related to course: https://nptel.ac.in/courses/108101112

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Microwave Theory and Techniques)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	1	2	1	1	2	1	2	2	2	2	1	1.58
CO-2	2	3	3	3	3	1	2	1	1	2	1	1	1.92
CO-3	3	2	2	2	3	1	1	1	2	2	2	1	1.83
CO-4	2	3	3	3	2	1	2	1	1	3	1	2	2.0
CO-5	3	3	3	3	2	1	1	1	2	3	2	1	2.08
CO-6	3	3	2	2	3	1	1	1	1	2	1	2	1.83
Average	2.5	2.5	2.5	2.33	2.33	1.16	1.33	1.16	1.5	2.33	1.5	1.33	

Antenna and Wave Propagation

COURSE CODE: 18B1WEC735

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

1. To make students understand the fundamental theory and concepts of antenna and propagation of waves.
2. Make them aware to the radiation characteristics of different types of antennas, their measurement and applications of various antennas.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	Comprehend the fundamental theory and concepts of radiation, antenna and significance of antenna parameters.	Familiarity
CO-2	Assess the power and usefulness of UHF, VHF and Microwave Antennas, microstrip patch antennas their requirements, specifications, characteristics and design relations.	Assessment
CO-3	To define and distinguish between different phenomenon of wave propagation (ground wave, space wave and sky wave), their frequency dependence, and estimate their characteristics, identifying their profiles and parameters involved.	Assessment
CO-4	Reveal different applications of the various types of antenna to solve engineering and other problems	Usage

Course Contents:

Unit	Contents	Lectures required
1	ANTENNA FUNDAMENTALS: Introduction, Radiation Mechanism – single wire, 2 wire, dipoles, Current Distribution on a thin wire antenna. Antenna Parameters - Radiation Patterns, Beamwidths, Beam Area, Radiation Intensity, Beam Efficiency, Directivity, Gain and Resolution, Antenna Apertures, Aperture Efficiency Antenna temperature and signal to noise ratio.	7
2	RADIATION OF ELECTRIC DIPOLE: Potential functions and the electromagnetic field, Oscillating electric dipole derivations for E and H field components in spherical coordinate systems, Power Radiated by a current element, Application to antennas, Radiation from quarter wave monopole and half wave dipoles, equality of directional patterns and effective lengths of transmitting and receiving antennas, directional properties of dipole antennas, antenna feeding methods.	8

3	ANTENNAS FOR SPECIAL APPLICATIONS: Broadband antenna, Frequency-independent antenna, log periodic antennas, Antennas design consideration for satellite communication, antenna for terrestrial mobile communication systems, GPR, Embedded antennas, UWB, Plasma	6
4	ANTENNA MEASUREMENTS: Radiation Pattern measurement, Distance requirement for uniform phase, uniform field amplitude requirement, Introduction to phase measurement; Gain Measurement: Comparison method, Near field method, Introduction to current distribution measurement, Measurement of antenna efficiency, measurement of Noise figure and noise temperature of an antenna polarization measurement, Anechoic Chamber measurement.	7
5	WAVE PROPAGATION - I: Concepts of Propagation – frequency ranges and types of propagations. Ground Wave Propagation–Characteristics, Parameters, Wave Tilt, Flat and Spherical Earth Considerations. Sky Wave Propagation – Formation of Ionospheric Layers and their Characteristics, Mechanism of Reflection and Refraction, Critical Frequency, MUF & Skip Distance – Calculations for flat and spherical earth cases, Optimum Frequency, LUHF, Virtual Height, Ionospheric Abnormalities, Ionospheric Absorption.	7
6	WAVE PROPAGATION – II: Fundamental Equation for Free-Space Propagation, Basic Transmission Loss Calculations. Space Wave Propagation – Mechanism, LOS and Radio Horizon. Tropospheric Wave Propagation – Radius of Curvature of path, Effective Earth's Radius, Effect of Earth's Curvature, Field Strength Calculations, M-curves and Duct Propagation, Tropospheric Scattering.	7
Total lectures		42

Suggested Text Book(s):

1. E.C.Jordan and Balmain: Electromagnetic waves and Radiating Systems, 2nd Edition, PHI, 2006
2. Constantine A. Balanis: Antenna Theory Analysis and Desin, John Wiley, 2nd Edition,2007.

Suggested Reference Book(s):

1. John D.Kraus, Ronald J Marhefka and Ahmad S Khan: Antennas for all Applications, Tata McGraw-Hill Book Company, 3rd Edition, 2007.
2. G.S.N.Raju: Antenna Wave Propagation, Pearson Education, 1st Edition, 2004.
3. R.E.Collins, "Antenna and Radiowave propagation", 3rd Edition, Mc Graw Hill, 2005.

Other resources/ learning website:

www.nptel.ac.in

www.antenna-theory.com

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2

3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Antenna and Wave Propagation)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	2	2	3	2	1	1	1	2	3	3	2.17
CO-2	3	3	3	3	3	2	1	1	1	2	2	3	2.25
CO-3	3	3	3	3	3	2	1	1	1	2	2	3	2.25
CO-4	3	3	3	3	3	3	3	2	3	3	3	3	2.92
Average	3	3	2.75	2.75	3	2.25	1.5	1.25	1.5	2.25	2.5	3	2.40

Design of Modern Antennas

COURSE CODE: 18B1WEC831

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Transmission lines and E.M waves.

Course Objectives:

1. To learn the mechanism of antenna, antenna performance parameters.
2. Design and analysis of various antennas for different applications.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	To define overall needs and constraints of RF systems and antennas.	Familiarity
CO-2	To understand the mechanism of antenna radiation.	Familiarity
CO-3	To design and analyze various antennas for specific application.	Usage
CO-4	Size reduction techniques, Broad banding and multi band operation techniques in antenna design.	Usage
CO-5	Evaluate the opportunities involving technology, a product or a service required for developing a startup idea.	Assessment

Course Contents:

Unit	Contents	Lectures required
1.	Introduction: antenna types, radiation mechanism, use of potential functions, radiated field, far field, antenna parameters, radiation pattern, directivity, numerical evaluation of directivity, gain, efficiency, impedance, loss resistance, polarization, linear polarization, circular and elliptic polarization, equivalent area, Friss equation.	6
2.	Dipole Antennas: Potential functions for analysis of radiated fields, Duality theorem, Reciprocity theorem for antennas, Radiation from current element, infinitesimal dipole, finite length dipole, half wave dipole	6
3.	Antenna Arrays: Analysis and Synthesis Review of antenna array basics, Linear arrays, circular array, planar (2D) arrays, sum and difference patterns, Effect of mutual couplings, Phased array antennas, scan Principles, Non uniform arrays, Dolph Chebyshev Arrays Binomial Arrays.	6
4	Broadband and Frequency Independent Antennas Helical antenna: Normal mode and axial mode helix Spiral antennas, Log Periodic antennas.	5

5.	Aperture Antennas Radiation from an aperture in an infinite ground plane, Radiation from rectangular and circular apertures, Radiation from a slotted rectangular waveguide Horn antenna: E plane and H plane sectoral horns, Pyramidal horn, Conical horn Reflector antennas parabolic reflector, methods of analysis, dual reflector antennas, offset reflector antenna, gain and efficiency calculations, scanning properties and cross polarization Lens antennas and their applications	7
6	Microstrip Antennas Rectangular patch antenna: cavity and transmission line models, Circular patch antenna Coupling mechanisms, circular polarization, Microstrip arrays, Broadband and Multi band microstrip antennas, Compact Microstrip Antennas.	7
7	Dielectric Resonator Antennas Introduction, radiation mechanism, advantages of DRA, types of DRA, feeding techniques, design method, modes.	5
Total lectures		42

Suggested Text Book(s):

1. Constantine A. Balanis: Antenna Theory Analysis and Desin, John Wiley, 3rd Edition, 2009.
2. Antennas for All Applications, J. D. Kraus and R. J. Marhefka, McGraw-Hill, Inc, 3rd Ed., 2007.
3. Rectangular Dielectric Resonator Antennas, Rajveer S. Yaduvanshi Harish Parthasarathy, Springer, 1st Ed, 2016.

Suggested Reference Book(s):

1. Antennas and Radio wave Propagation, R. E. Collin, McGraw-Hill, Inc, 3rd Ed, 2005.
2. Modern Antenna Design, T. A. Milligan, John Wiley & Sons, 2nd Ed., 2005.
3. Antenna Arrays, R. L. Haupt, John Wiley & Sons, Inc., 1st Ed., 2010.
4. Antenna Theory and Microstrip Antennas, D. G. Fang, CRC Press, 1st Ed., 2009.

Other useful resource(s):

Link to NPTEL course contents

1. https://nptel.ac.in/courses/108101092/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered up to T-1
2	T-2	25	1.5 Hours	Syllabus covered up to T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes(2) -10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Design of Modern Antennas)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	3	3	3	2	1	1	1	2	2	2	2.2
CO-2	2	3	3	3	2	2	1	1	2	1	1	2	1.9
CO-3	2	2	2	3	2	2	1	1	1	2	1	3	1.8
CO-4	2	2	3	3	2	1	1	2	2	2	2	2	2
CO-5	2	2	3	3	3	2	1	1	2	2	1	2	2
Average	2.2	2.4	2.8	3	2.4	1.8	1	1.2	1.6	1.6	1.4	2.2	

RF Engineering

COURSE CODE: 18B1WEC835

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Basic knowledge of Electromagnetic Engineering

Course Objectives:

1. To lay strong foundations in RF and microwave engineering.
2. To apply the theoretical knowledge acquired in the design of different components in microwave systems.

Course Outcomes:

S. No.	Course Outcomes	Level of Attainment
CO-1	To have a thorough knowledge of RF and microwave components	Familiarity
CO-2	To have a thorough knowledge about different parameters involved in microwave receiver and their significance	Assessment
CO-3	To have a thorough knowledge about different parameters involved in microwave receiver and their significance	Assessment
CO-4	To design different RF filters according to certain specifications	Usage
CO-5	To understand active microwave components and their use in different applications	Usage

Course Contents:

Unit	Contents	Lectures required
1	Review of Waves and Transmission Lines: Wave Propagation, Transmission Line Equations, Reflection, Transmission, and impedance for a Terminated Transmission Line, Voltage Standing-Wave Ratio, Decibels, insertion Loss, Return Loss, Smith Charts, S-Parameters, Impedance Matching Networks.	5
2	Receiver System Parameters: Typical Receivers, System Considerations, Natural Sources of Receiver Noise, receiver Noise Figure and Equivalent Noise Temperature, Compression Points, Minimum detectable Signal and Dynamic Range, Third-Order Intercept Point and Intermodulation, spurious Responses, Spurious-Free Dynamic Range	8
3	Transmitter and Oscillator Systems: Transmitter Parameters, Transmitter Noise, Frequency Stability and Spurious Signals, Frequency Tuning, Output Power, and Efficiency, Intermodulation, Crystal Reference Oscillators, Phase-Locked Oscillators, frequency Synthesizers	6
4	Design of RF filters: Periodic Structures, Filter Design by the Image Parameter Method, Filter Design by the Insertion Loss Method, Characterization by Power Loss Ratio Filter transformations, Filter Implementation, Stepped-Impedance Low-Pass	9

5	Fabrication Technologies: Lumped Elements for RF circuits: Basic Design of Lumped elements, Lumped element modeling, printed inductors, MIM capacitor and Interdigital capacitor, Monolithic Integrated circuit technology (MIC), Monolithic microwave integrated circuit (MMIC) technology, material, RF printed circuit boards.	9
6	Wireless Communication Systems: Friis Transmission Equation, Space Loss, Link Equation and Link budget, Effective Isotropic Radiated Power and G/T Parameters, Radio/Microwave Links, Satellite Communication Systems, Mobile Communication Systems and Wireless cellular phones, Personal Communication Systems	5
Total lectures		42

Suggested Text Book(s):

1. Kai Chang, "RF and Microwave Wireless Systems",1st Edition, John Wiley & Sons, 2002.
2. Pozar, David M. "Microwave engineering", 4th Edition, John Wiley & Sons, 2013.
3. Bahl I.J "Lumped Elements for RF and Microwave Circuits"1st Edition, Artech House,2003.

Suggested Reference Book(s):

4. R.E.Collin, "Foundations for microwave Engineering", 2nd Edition, John Wiley & Sons, 2007.
5. Annapurna Das, Sisir.K.Das, "Microwave Engineering",1st Edition, Tata McGraw Hill, 2000.

Other useful resource(s):

Link to NPTEL course contents:

https://nptel.ac.in/courses/117101119/

https://nptel.ac.in/courses/117105138/

Link to topics related to course:

https://nptel.ac.in/courses/117105138/ 1 to 18

https://nptel.ac.in/courses/117101119/ 1 to 14

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (RF Engineering)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	2	1	1	1	2	1	2	1.7
CO-2	2	3	2	3	2	2	1	1	1	2	1	2	1.8
CO-3	3	3	3	3	3	2	1	1	1	2	1	2	2.1
CO-4	2	2	2	2	2	2	1	1	1	3	1	2	1.8
CO-5	3	2	3	2	2	2	1	1	1	2	1	2	1.8
Average	2.4	2.4	2.4	2.4	2.2	2.0	1.0	1.0	1.0	2.2	1.0	2.0	

Industrial Plant Tissue Culture

COURSE CODE: XXXXXXXX

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Cell Culture Technology

Course Objectives:

1. To provide an insight and understanding about different aspects of plant cell and tissue culture technologies
2. Learn about latest scientific and commercial advancements in plant cell and tissue culture.
3. Apply basic knowledge for developing novel products and production for commercialization

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	To enable students for applying the knowledge about basic techniques of plant cell and tissue culture.	Familiarity
CO-2	To apply the learnt techniques for solving constraints linked with production of in vitro plants and phytochemicals through cell and tissue culture technologies	Analytical and Technical skills
CO-3	Able to learn the strategies and techniques for conservation of plant germplasm	Assessment
CO-4	To enable students for exploring their avenues for entrepreneurship through skill development	Usage
CO-5	Able to apply knowledge of plant biotechnology for effective planning and strategizing of projects .	Technical
CO-6	Able for developing skills for benefit generation and utilization of plant tissue culture techniques for commercialization and entrepreneurship	Analytical and Technical skills

Course Contents:

Unit	Contents	Lectures required
1	**Introduction:** Introduction of plant tissue culture, historical events and different commercial units associated	3
2	**Different Techniques :**Organ culture, somatic embryos, haploids , callus and suspension cultures applied in different plant species Protoplast isolation, culture and regeneration. Somatic hybridization and cybridization.	9
3	**Conservation techniques:**In situ and ex situ conservation of plant germplasm including cryopreservation	4
4	**Plant cell and tissue modification techniques:**Plant genetic modification by direct and indirect methologies Development of Transgenics plants Somaclonal variations Cartagena protocols and CBD	6
5	**Secondary metabolites in plants:**Secondary metabolites, classifications and biosynthesis and accumulation. Production of secondary metabolites through cell culture and their commercial production and usage. Quantification of secondary metabolites	6
6	**Legal perspectives:**Plants Breeder's Right, Convention on Biological Diversity ,Biodiversity Act and Traditional Knowledge Act	4
7	**Large scale production:**Hydrophonics and Aquaphonics set ups along with their industrial applications Bioreactor setups for large scale production of planting material and products	4
Total lectures		**42**

Suggested Text Book(s):

1. Micropropagation: Technology and Application by P.C. Debergh and R.H. Zimmerman Kluwer Academic Publishers.
2. Introduction to plant tissue culture by M. K. Razdan.

3. Plant Cell and Tissue Culture - A Tool in Biotechnology: Basics and Application Book by Ashwani Kumar, Jafargholi Imani, and Karl-Hermann Neumann

Suggested Reference Book(s):

1. Plant Culture Media, Volume 1,Formulations and Uses by E.F. George, D.J.M. Puttock and H.J.George.
2. Plant cell and tissue culture for the production of food ingredients By Tong-Jen Fu, Gurmeet Singh, Wayne R. Curtis, American Chemical Society.

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	**1.7**
CO-2	2	2	1	2	2	2	1	1	1	1	1	2	**1.5**
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	**1.7**
CO-4	2	2	3	3	2	1	1	1	2	2	2	2	**1.9**
CO-5	2	1	1	1	2	1	2	1	1	1	1	1	**1.2**
CO-6	2	1	1	2	2	2	1	1	2	2	2	2	**1.6**
Average	**3.4**	**2.8**	**1.6**	**2**	**2.1**	**1.3**	**1.1**	**1**	**1.6**	**1.6**	**1.5**	**1.8**	

Manufacturing Process and Industrial Products

COURSE CODE :

COURSE CREDITS : 03

L-T-P : 3-0-0

CORE/ELECTIVE : Elective

Pre-requisite: None

Course Objectives:

The objective of this course is to learn the advanced technologies in manufacturing of therapeutic and plant-based biotechnological products which coupled with the industrial-scale knowledge of biotechnological production and latest downstream process scheme and techniques.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Manufacturing technologies for Therapeutic and Pharmaceutical compounds	Familiarity and Usage
CO-2	Manufacturing of plant-based bioactive /secondary compounds	Familiarity and Usage
CO-3	Manufacturing of Alcoholic beverages	Familiarity and Usage
CO-4	Manufacturing Biotechnological products: Industrial scale approaches	Familiarity and Usage
CO-5	Manufacturing technologies for Biotechnological products: Advanced DSP Approaches	Familiarity and Usage

Course Contents:

Unit	Contents	Lectures required
1	**Manufacturing technologies for Therapeutic and Pharmaceutical compounds** Microbial production Technology of Therapeutic enzymes: L-asparaginase, L-glutaminase, Pencillin acylase and nattokinases Biocatalysts towards production of pharmaceutically active racemic mixtures	12
2	**Manufacturing of plant-based bioactive**	7

	/secondary compounds Plant-Associated Microorganisms (Endophytes) as a New Source of Bioactive Natural Products Biotechnological Methods for Selection of High-Yielding Cell Lines and Production of Secondary Metabolites in Medicinal Plants	
3	**Manufacturing of Alcoholic beverages** Wine Biotechnology: Manufacturing and technological considerations of White, Red, Sparkling, Fortified, and Cider	5
4	**Manufacturing Biotechnological products: Industrial scale approaches** Industrial-Scale Fermentation Scale-Down: Simulating Large-Scale Cultures in the Laboratory	9
5	**Manufacturing technologies for Biotechnological products: Advanced DSP Approaches** Schematic approaches for the Isolation and Purification of Fermentation Products Advances in Biochromatography: Dye-ligand Affinity chromatography, Immobilized metal-ion affinity chromatography (IMAC) and Immobilized histidine ligand affinity chromatography	9
	Total Lectures	42

Suggested Text Book(s):

- Current Developments in Biotechnology and Bioengineering: Production, Isolation and Purification of Industrial Products by Ashok Pandey, Sangeeta Negi, Carlos Ricardo Soccol

- Medicinal Plant Biotechnology by Oliver Kayser and Wim J. Quax
- Current Developments in Biotechnology and Bioengineering: Food and Beverages Industry Edited by Ashok Pandey, Maria A´ngeles Sanroma´n, Guocheng Du, Carlos Ricardo Soccol, Claude-Gilles Dussap
- Industrial Biotechnology by Christoph Wittmann and James C. Liao
- Biochromatography: Theory and practice Edited by M.A.Vijayalakshmi

- Review and research articles from Science Direct, Springer, Wiley and PubMED publishers

Course outcomes	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12
CO-1	2	2	3	1	1	2	2	3	2	2	1	2
CO-2	1	2	2	2	2	1	-	2	2	2	1	3
CO-3	2	2	2	2	2	2	1	1	2	-	2	2
CO-4	2	3	2	1	2	1	-	1	3	2	-	2
CO-5	1	3	1	3	2	2	1	2	1	2	1	3

Industrial Enzymes Technologies

COURSE CODE:18B1WBT731

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Enzyme production purification and applications

Course Objectives:

1. The objective of the course is to develop an understanding of important aspects of production and purification of industrially important enzyme and their application in industry.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	To develop an understanding of basic concepts of enzymes.	Familiarity
CO-2	To understand the basic mechanism of action and working behaviour of enzymes	Assessment
CO-3	To familiarize the students with various applications of enzymes in laboratory as well as Industrial scale.	Assessment
CO-4	To conceptualize about immobilized enzyme technology, and other specific enzymes and their applications.	Usage
CO-5	To familiarize the students with present potential of enzyme in industrial application and improved activity of the enzyme using various molecular biology techniques.	Usage
CO-6	To understand the principle and function of enzyme in various adverse conditions like high temperature and pH(s).	Assessment

Course Contents:

Unit	Contents	Lectures required
1	**Enzymes: Basic concepts:**Enzymes as powerful and highly specific catalysts, Classification of enzymes, free energy and enzymes, the formation of the transition state, catalytic strategies. General properties: Enzyme specificity, stability and structure, Factors affecting enzyme activity; effect of pH and Temperature, Substrate and Enzyme concentration.	**5**

2	**Enzyme kinetics**: Michaelis-Menten kinetics, evaluation of parameters in the Michaelis-Menten equation, 3-D structure of active site, Kinetics of single and bi-substrate enzyme catalysed reactions, Inhibition & its kinetics.	**5**
3	**Enzyme preparation techniques:** Sources of enzymes, production,Recovery and purification of intracellular products: cell disruption, chromatographic techniques. Analytical assays of purity level of enzymes.	**3**
4	**Enzyme preparation and application in industries:** Application of enzymes in leather, glucose syrup production, starch and sugar industry, Dairy and food industry, Beverage industry, Textile industry. Hydrolysis of starch and cellulose. Catalytic functions of Cellulase, lipase, esterase laccase amylase, glucose isomerase, protease, xylanase, invertase, peroxidises. Other applications of enzymes in solution: medical applications of enzymes, non-hydrolytic enzymes in current and developing industrial technology.	**10**
5	**Enzyme engineering:** Mechanisms and manifestations of protein denaturation. Strategies for enzyme stabilization: Physical and chemical modifications, Selection, directed evolution and Rational design. design and construction of mutant enzymes, Bifunctional and polyfunctional enzyme, Enzyme in organic solvents.	**5**
6	**Immobilized-enzyme technology**: Introduction, enzyme immobilization method: Entrapment, carrier-binding and cross-linking method. Medical and analytical applications of immobilized enzymes.	**8**
7	**Specified Enzymes and applications:** Thermozymes, Cold adapted enzymes, Ribozymes, Hybrid enzymes, Diagnostic enzymes, Therapeutic enzymes: Characteristics, principles and applications.	6
Total Lectures		**42**

Suggested Text Book(s):

1. Devasena, T., "Enzymology", 1st ed., Oxford University Press, 2010
2. Berg, J.M., Tymoczko, J.L. and Stryer, L., "Biochemistry", 5th ed., W.H. Freeman and Company, New York, 2002.
3. Nelson D.L., Cox M.M., "Lehninger Principles of Biochemistry", 5th ed., W.H. Freeman and Company, New York, 2008.

Suggested Reference Book(s):

1. Pye, E.K. and Wingard, L.B., "Enzyme Engineering II", Plenum Press, 1974.
2. Illanes A, "Enzyme Biocatalysis", Springer Science, 2008.

Other useful resource(s):

https://nptel.ac.in/course.php?disciplineId=102

Course Outcomes (COs) contribution to the ProgrammeOutcomes(POs)

Course outcomes	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	3	1	1	2	2	3	2	2	1	2	1.9
CO-2	1	2	2	2	2	1	-	2	2	2	1	3	1.8
CO-3	2	2	2	2	2	2	1	1	2	-	2	2	1.8
CO-4	2	3	2	1	2	1	-	1	3	2	-	2	1.9
CO-5	1	3	1	3	2	2	1	2	1	2	1	3	1.8
CO-6	1	1	-	2	2	2	2	1	2	2	1	3	1.7
Average	1.5	2.1	1.6	1.8	1.8	1.6	1	1.6	2	2	1.2	2.5	

Bio-resources and Industrial Products

COURSE CODE: XXXXXX
COURSE CREDITS: 3
CORE / ELECTIVE: Elective
L-T-P: 3-0-0

Pre-requisite: Fundamental Chemistry and Advanced Biology

Course Objectives:

1. The objective of the course is to develop an understanding of different type of bio-resources.
2. To learn about the various industrial products that is derived from microbes, plant, and animal.
3. Learn about bio-renewable and non renewable products.

Course Outcomes

S. No.	Course Outcomes	Level of Attainment
CO I	Introduction to Bio-resource, use of Biodiversity and different Scale of Bio-resource Engineering, Processing Technology	Familiarity
CO II	Introduction to different bio-resources for industrial product development	Assessment & Technical
CO III	Microbial bio-resources: Isolation and Application in food, medicine and other industrial product.	Assessment & Technical
CO IV	Novel plant and animal bio-resources: Isolation and Application in food, medicine, cosmetics and textile industries	Usage
CO V	Fundamental understanding of Processing Technology: processes for converting Raw material to bio-based product	Usage

Topic Covered:

S. No.	Unit	Topics Covered	Contact Hrs.
1	Overview: Introduction and History	Various definitions and Concept of Bio-resources & Historical background Fundamental concept of bio-resources Engineering and different Scale of Bio-resource Engineering	5
2	Bio-resources for industrial product	Major category of bio-resources: Microbial bio-resources, animal based bio-resources and plant based bio-resources. Value of bio-resources in various industrial product developments.	6
3	Microbial bio-resources and their application in Industries	Use of microbial bio-resources for human welfare: microbial bio-resources in cosmetics, use of microbial resources in food industries and pharmaceutical industries. Useful Microorganisms for Environmental Sustainability: Application of Heavy Metal Tolerant Consortia for Surface Water Decontamination in Natural and Artificial Wetlands	8
4	Plant based bio-resources and their application in Industries	Use of Plant based bio-resources for human welfare: in bio-cosmetics (Aloe vera, Crocus sativus and Santalum album), bio-preservatives (vinegar, sugar), use of plant resources in pharmaceutical industries, SAR,	8

		antioxidant, anticancer, immunostimulant drug development. Application in food industries: food supplement, beverages, fodder, bio-sweetener etc.	
5	Animal based bio-resources and their application in Industries	Use of Animal based bio-resources for human welfare: in dairy industries (various dairy product: cheese, milk, ice cream etc), bio-cosmetics. In textile industries (Pashmina, angora wool), Honey, meat industries etc.	8
6	Processing Technology	Bio-refinery Concept, processes for converting Raw material to bio-based product, novel development in Processing Technology.	5
7	Case Study	Case study of lignocellolose-Ethanol Processing	2
	Total Number of Lectures		**42**

Methodology

The course will be covered through lectures. Apart from discussions on topics covered in lectures, assignments and conceptual problems will also be given.

TEXT BOOKS

1	Novel Plant Bioresources: Applications in Food, Medicine and Cosmetics, Ameenah Gurib-Fakim, WILEY.
2	Emerging Bioresources with Nutraceutical and Pharmaceutical Prospects: Seema Patel San Diego State University, San Diego, California, USA, Springer
3	Dairy Chemistry and Biochemistry P.F. FOX and P.L.H. McSweeney Department of Food Chemistry University College, Cork Ireland

REFERENCE MATERIAL

1	Review articles on relevant topics from diverse sources
2	Animals in Traditional Folk Medicine: R. R. N. Alves, I. L. Rosa. Springer Heidelberg New York Dordrecht
3	Renewable Bio-resources Scope and Modification for Non-food Applications: C. V. Stevens, R. Verhé, Wiley

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	Average
CO-1	2	2	1	2	2	2	2	1	2	2	2	2	2	2	1.8
CO-2	1	2	1	2	2	2	2	2	2	2	1	2	3	2	1.8
CO-3	2	3	3	3	3	2	3	2	2	1	2	2	3	2	2.3
CO-4	2	3	3	3	3	2	3	2	2	1	2	2	3	2	2.3
CO-5	2	2	3	3	2	2	3	2	2	1	2	2	3	2	2.3
Average	1.8	2.4	2.2	2.6	2.4	2.0	2.6	1.8	2.0	1.4	1.8	2.0	2.8	2.0	

Food Processing and Engineering

COURSE CODE

COURSE CREDITS: 3

CORE/ELECTIVE:

L-T-P: 3-0-0

Pre-requisite: Biology

Course Objectives

1. This course is designed to make the students familiar with the processes employed in the manufacture of food products and Engineering aspects of food processes at commercial scale.
2. Students specializing in food engineering learn to apply engineering principles and concepts to handling, storing, processing, packaging, and distributing food and related products.

Course Outcomes

Sr. No.	Course outcomes	Level Attainment
CO I	Students become aware of Concept of Food Processing and Engineering.	Familiarity
CO II	Students will acquire knowledge about processing techniques of different food commodities.	Familiarity
CO III	Will develop understanding the basic principles and equipments used in food Processing.	Assessment
CO IV	Students will learn engineering aspects and equipments used of common unit operations of food processing.	Usage
CO V	Will develop understanding of food packaging methods and trends in this area	Usage

Topic Covered

S. No.	Contents	Contact Hrs.
	Module I Food Processing	
1	Food Processing and Engineering Concept, Scope, Importance and Subject matter	1
2	Food Fermentation Benefits of fermentation - nutritive value of fermented food, Microorganisms in fermented foods: Case studies of manufacturing of some non alcoholic Fermented Foods: Sauerkraut, Soy based fermented products, dairy products	4
3	Fruit Processing Techniques Apple Processing, Anola Processing, Grapes processing, Banana Processing, Citrus Processing, Guava Processing, Mango Processing, Pineapple Processing	5
4	Vegetable Processing Techniques Tomato Processing Cabbage Processing, Carrot Processing, Cauliflower Processing, Garlic Processing, Onion Processing, Ginger Processing, Potato Processing	5
	Module II Food Process Engineering	
5	Basic Principles and Equipments used in Food Processing	8

	Steam generation and utilization, Refrigeration, Heat exchange and heat exchange Equipments	
6	Principles and Equipments involved unit operations of food processing Size reduction and separation, Evaporation and evaporation equipments, Dehydration and Drying equipments, Material handling and transportation	13
7	Food Packaging Thermal and Non-thermal processing for packaging, packaging material, Advanced and innovative packaging technologies	3
8	Plant Design, Location and Equipment Layout**:** General Principles, Design and Functionality of Building, Design and Fabrication of Equipments, Plant Location, Role of Food Engineers'	3
	Total Number of Lectures	42

REFERENCE & TEXT BOOKS

1. Guide to Post Harvest Uni Operations – NK Dhamsaniya, Kalyani
2. Food Microbiology: Fundamentals and frontiers - M.P. Doyle, L.R. Beuchat and Thomas J. Montville, (2001), ASM press, USA
3. Post Harvest Management and Processing of Fruit and Vegetable – NS Tathore GK Mathur and SS Chasta
4. Fundamental Of Food Engineering - DG Rao PHI Learning Pvt Ltd

Course outcomes	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**
CO-1	2	2	3	1	1	2	2	3	2	2	1	2
CO-2	1	2	2	2	2	1	-	2	2	2	1	3
CO-3	2	2	2	2	2	2	-1	1	2	-	2	2
CO-4	2	3	2	1	2	1	-	1	3	2	-	2
CO-5	1	3	1	3	2	2	1	2	1	2	1	3

Bioprocess Modelling and Simulation

COURSE CODE:

COURSE CREDITS: 3

CORE/ELECTIVE: Elective

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

The objective of this course is to learn the modeling and optimization approaches for model and optimize the different biotechnological processes. This approach is helpful to scale up the biotechnologal process and improves the yield of Biotechnological products.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Introduction and Importance of Modelling in Bioprocess technologies	Familiarity
CO-2	Role of optimization in enhanced yields in Bioprocess systems	Familiarity
CO-3	Necessity of Design of experiments in modeling and optimization approaches	Familiarity
CO-4	Types of modeling and optimization approaches for Bioprocess systems	Usage
CO-5	Application of modeling coupled optimization tools for bioprocess systems	Usage

Course Contents:

Unit	Contents	Lectures required
1	Introduction to Modeling and Different Types of models	**5**
2	Introduction to optimization and classical optimization techniques	5
3	Introduction to experimental Design and Types of Experimental Designs	8
4	Modelling & optimization through Response Surface Methodology and Taguchi Methodology	**8**

5	Modeling based on neural networks and Experimental validation of neural network models	6
6	Evolutionary and swarm intelligence based optimization approaches for optimization of Biological process	10
Total lectures		**42**

Suggested Text Book(s):

4. Modelling and Simulation by G. Francis,
5. Modelling and Optimization of Biotechnological Processes by Chen, Nguang and Chen, Springer
6. Biologically Inspired Algorithms for Financial Modelling by Brabazon · Michael O'Neill, Springer
7. Modelling microbial responses in Food by McKeller and Lu, CRC Press
8. Engineering optimization by S.S.Rao, Wily-Interscience
9. Extraction and optimization of Food Engineering by Coustantina Tzia, Marcell-Dekker
10. Design and optimization in Organic synthesis by Carlson and Carlson, Elsevier
11. Design and Analysis of Experiments by Dean and Voss, Springer
12. Design and Analysis of Expeiments by Montgomery, John Wiley & Sons
13. Design of Experiments Using the Taguchi Approach by Roy, Ranjit K, John Wiley & Sons, Inc. (US)
14. Design and Analysis of Experiments by Hinkelmann and Kempthorne, Wiley Interscience
15. Differential Evolution by Feoktistov, Springer
16. Response surface methodology and related topics by Khuri, World Scientific
17. Particle swarm optimization by Clerc, ISTE
18. Soft computing by D.K.Prathihar, Narosa Publishers

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	3	3	2	2	1	1	1	1	1	1	
CO-2	3	3	3	3	3	1	1	1	1	1	1	3	
CO-3	3	3	2	3	2	3	2	1	1	1	2	1	

CO-4	3	3	3	2	3	2	1	1	1	1	1	1	
CO-5	2	2	3	3	3	3	1	1	1	1	1	1	
Average													

Stem Cells and Regenerative medicines

COURSE CODE: 14B1WBT739

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Basic understanding of biology and cell culture

Course Objectives

The objective of the course is to develop an understanding of important concepts and design aspects of bioreactors and their functioning and scale up.

Course Outcomes

CO I	Able to understand current medicine therapy and embryonic stem cell
CO II	Able to understand different tissues and adult stem cell
CO III	Able to understand heart, muscle and neural stem cells
CO IV	Able to understand regenerative medicine and application of stem cells
CO V	Able to understand tissue engineering

Course Content

S. No.	Unit	Topics Covered	Contact Hrs.
1	Introduction	Overview of current medicine and therapy, introduction to stem cells, and regenerative therapy. Totipotency, pluripotency, multipotency, progenitors, etc. Different types of stem cells –embryonic , adult stem cells, induced pluripotent cells (iPSCs), localisation, niche, etc.	4
2	EMBRYONIC STEM CELLS, NUCLEAR REPROGRAMMING, AND STEM CELL FATE	Development of Diverse Hematopoietic Cell Populations from Human Embryonic Stem Cells Using Embryonic Stem Cells as a Model of Pancreatic Development Isolation and culture of mesenchymal stem cells	8
3	ADULT STEM CELLS	Introduction to different tissues and systems of human body. Multipotent Adult Progenitor Cells, localisation and stem cell proliferation. Neural stem cells, bone marrow cells, Ocular Surface Epithelial Stem Cells, etc	4

4	STEM CELLS FOR MUSCLE AND HEART	Stem Cells in Skeletal Muscle Regeneration, Myogenic Precursor Cells in the Extraocular Muscles, Treating Coronary Heart Disease with Progenitor-Cell-based Repair, Postnatal Stem Cells for Myocardial Repair.	6
5	STEM CELLS FOR THE NERVOUS SYSTEM	Use of a β -Galactosidase Reporter Coupled to Cell-Specific Promoters to Examine Differentiation of Neural Progenitor Cells In Vivo and In Vitro From Neural Stem Cells to Neuroregeneration Cochlear Stem Cells/Progenitors Intravascular Delivery Systems for Stem Cell Transplantation in Neurologic Disorders Stem Cell Strategies for Treating Inner Ear Dysfunction	9
6	Regenerative Medicine	Regenerative Medicine : Overview, Gene therapy, regenerative medicine, Bioprinting, Stem Cells and Regenerative Medicine in diseases, Genetic Reprogramming	4
7	Tissue Engineering	Tissue engineering overview, Cells and Biomaterials : The Tissue engineering Approach, An overview of various Scaffolds, Regulation of cell function in tissue engineering, scaffold fabrication techniques, Bioreactor in Tissue Engineering, Transplantation Immunology: Organ and Tissue Transplantation Immunosuppressive Agents, Immunosuppressive Therapy	7
		Total Number of Lectures	**42**

Methodology

The course will be covered through lectures. Apart from discussions on topics covered in lectures, assignments and numerical problems will also be given.

TEXT BOOKS

1	Krishnarao Appasani and Raghu K. Appasani, Stem Cells & Regenerative Medicine, Humana Press
2	Walter C. Low and Catherine M. Verfaillie, Stem Cells and Regenerative Medicine, World Scientific Publishing Co. Pte. Ltd USA (2008)

Course out Come

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
	Stem cell and regenerative medicine													
CO1	2	2	2	2	2	3	1	2	1	2	2	2	3	2
CO2	2	2	3	1	1	2	1	3	2	1	2	2	3	2
CO3	3	2	3	2	2	3	1	2	2	2	2	2	3	2
CO4	3	2	3	3	3	3	3	2	2	2	3	2	3	3
CO5	3	2	3	3	3	3	3	2	2	2	3	2	3	3
	2.6	**2**	**2.8**	**2.2**	**2.2**	**2.8**	**1.8**	**2.2**	**1.8**	**1.8**	**2.4**	**2.0**	**3**	**2.4**

Chemoinformatics

COURSE CODE: XXXXXXX

COURSE CREDITS: 3

CORE/ELECTIVE: CORE

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

1. To learn the basics of chemoinformatics and to design potential lead molecules against any disease that may be explored further as a potential candidate for the drug development.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO1	Introduction to chemoinformatics	Familiarity
CO2	Design and optimize lead molecules against drug target, and using ligand-based approach	Usage
CO3	Determination of pharmacophore from lead molecules and active sites and use of pharmacophore for lead discovery	Usage
CO4	Development of potential drug molecule and pharmacophore databases for virtual screening	Assessment
CO5	Quantum chemistry fundamentals	Familiarity
CO6	Bioavailability prediction of a drug and working capability in drug designing software like, Discovery Studio and molecular dynamics software like AMBER 8.0, On-line tools, etc.	Assessment

Course Contents:

Unit	Contents	Lectures required
1	Introduction	4
2	Quantum chemistry	3
3	Receptor Fitting (Lead discovery& refinement)	9
4	Receptor Fitting (Lead optimization)	4
5	Receptor Mapping (Pharmacophore)	5
6	Representing 2D & 3D structures, 2D chemical database	4
7	Receptor Mapping (Quantitative structure activity relationship (QSAR))	6

8	Fragment-based Lead Discovery	4
9	ADMET	4
	Total	42

Suggested Text Book(s):

19. David C Young : Computational Drug Design (A guide for computational and medicinal chemists) Wiley & Sons, Inc., New Jersey, USA

20. Holtje H.-D, Sippl W., Rognan D. and Folkers G. : Molecular Modeling, Basic Principles and Applications Wiley-VCHGmbH & Co. KGaA

21. Leach AR : Molecular Modeling: Principles and Applications: Prentice Hall, Edinburg UK.

22. Zartler ER & Shapiro MJ : Fragment-based Drug Discovery (A practical approach), Wiley & Sons, Inc., West Sussex, UK

Flower DR : Drug design: cutting edge approaches, RSC publication, Cambrige, UK

Suggested Reference Book(s):

3. Merz KM, D Ringe, : Drug Design: Structure and Ligand-based Approaches. Reynolds CH Cambridge University Press

4. Opera TI : Chemoinformatics in Drug Discovery, Wiley-VCH, GMBH

5. Hubbard RE : Structure-based drug discovery (An overview), RSC publication, Cambrige, UK

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Average
CO1	3	3	3	3	2	2	1	1	1	1	1	1	**1.83**
CO2	3	3	3	3	3	1	1	1	1	1	1	3	**2.00**
CO3	3	3	2	3	2	3	2	1	1	1	2	1	**2.00**
CO4	3	3	3	2	3	2	1	1	1	1	1	1	**1.83**
CO5	2	2	3	3	3	3	1	1	1	1	1	1	**1.83**
C06	2	3	3	3	2	2	2	2	2	2	2	2	**2.25**
Average	**2.67**	**2.83**	**2.80**	**2.80**	**2.60**	**2.20**	**1.20**	**1.00**	**1.00**	**1.00**	**1.20**	**1.40**	

Clinical Data Management System

COURSE CODE: XXXXXXX

COURSE CREDITS: 3

CORE/ELECTIVE: Elective

L-T-P: 3-0-0

Pre-requisite: Basic Knowledge of Biology and Computers

Course Objectives:

1. This course is designed for individuals interested in the scientific, policy, and management aspects of clinical trials. Topics include types of clinical research, study design, treatment allocation, randomization and stratification, quality control, sample size requirements, patient consent, storage of the data and interpretation of results along with registration in clinical trial databases. Students design a clinical investigation data base in their own field of interest.

Course Outcomes:

CO I	To have the background essential for understanding the rationale behind clinical trials
CO II	To Understand database principles and data management
CO III	To understand the basic principles of clinical research
CO IV	To utilize the basic knowledge of clinical research into applied workflow of drug development.
CO V	To knowhow for setting up a clinical trial and managing the data along with the database set-up.

Course Content:

S.No.	Topic	No. of Lectures
1	Introduction , Pre Clinical Vs Clinical trials, Objectives and Principles, Various Phases of Clinical Trial	4
2	Statistics in clinical research	7
3	Data collection and management systems; Decision Support Systems	7
4	Study Design & trial consideration	4
5	Study population, Randomization process, Blinding, Sample size, Recruitment	2

6	Ethics, requirements pertaining to clinical research	2
7	Quality Control in clinical trials	2
8	Clinical trial Registries	4
9	Participant adherence, Survival analysis, Closure	2
10	Reporting and analysis evaluation of data	2
11	Multicenter trials	2
12	Globalization of clinical trials	2
13	Clinical trial scenario in India	2
	Total	**42**

TEXT AND REFERENCE BOOKS

1	Clinical Data Management (Second Edition) by Richard K. Rondel, Sheila A. Varley, Colin F. Webb. Wiley Publications.
2	Practical Guide to Clinical Data Management (Second Edition) by Susanne Prokscha. CRC Publications.
3	Statistical Aspects of the Design and Analysis of Clinical Trials by Brian S. Everitt and Andrew Pickles. Imperial College Press.